INEEL/EXT-03-00790
Revision 0
Project No. 23203

Hazard Identification Document for the OU 7-10 Stage III Project

July 2003

Idaho National Engineering and Environmental Laboratory
Bechtel BWXT Idaho, LLC

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July 2003

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Idaho Completion Project
Idaho Falls, Idaho 83415

Prepared for the
U.S. Department of Energy
Assistant Secretary for Environmental Management
Under DOE Idaho Operations Office
Contract DE-AC07-99ID13727

ABSTRACT

The purpose of this hazard identification document is to provide, during preconceptual design, information related to expected dominant hazards and resulting controls in the form of safety systems, structures, and components **(SSCs)** for retrieval, treatment, and storage of Operable Unit 7-10 (also known as Pit 9) waste-zone materials. Potential hazards associated with similar operations for other pits in the Subsurface Disposal Area will be considered. Project management, design, and engineering can use this information as a basis to make informed decisions while incorporating safety features in the conceptual design.

Potential hazards and operational, external, and natural events associated with retrieval and treatment options are identified and discussed. Included is a discussion of the radioactive and nonradioactive hazardous material inventories that could be encountered in Operable Unit 7-10 and in other areas of the Subsurface Disposal Area. Release and exposure events are postulated with consideration for each of the retrieval and treatment options identified at preconception design. Risks for each scenario are developed, and preliminary safety **SSCs** (i.e., safety significant or safety class) and technical safety requirement controls that may be needed are identified. Safety-significant **SSCs** have been identified for several scenarios; however, at this stage of the analysis and design, there are no safety-class **SSCs.**

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ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
AGV	automatic guided vehicle
AMWTP	Advanced Mixed Waste Treatment Project
BLEVE	boiling liquid-expanding vapor explosion
CAM	continuous air monitor
CEDE	committed effective dose equivalent
CCl_4	carbon tetrachloride
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
DOE-ID	U.S. Department of Energy Idaho Operations Office
EDF	engineering design file
ERPG	emergency response planning guideline
GAC	granulated activated carbon
INEEL	Idaho National Engineering and Environmental Laboratory
LLW	low-level waste
NRF–ECF	Naval Reactors Facility-Expended Core Facility
ORPS	Occurrence Reporting and Processing System
OSH	occupational safety and health
OU	operable unit
PC	performance category
PPE	personal protective equipment
PSAR	preliminary safety analysis report
RFP	Rocky Flats Plant
RWMC	Radioactive Waste Management Complex
SAR	*Safety Analysis Report*
SDA	Subsurface Disposal Area
SPERT	Special Power Excursion Reactor Test

SSC	system, structure, and component
TLV-TWA	threshold limit value-time-weighted average
TRU	transuranic
TSR	technical safety requirement
VOC	volatile organic compound
WIPP	Waste Isolation Pilot Plant

Hazard Identification Document for the OU 7-10 Stage III Project

1. INTRODUCTION

The purpose of this hazard identification document is to provide, during preconceptual design, information related to expected dominant hazards and resulting controls in the form of safety systems, structures, and components **(SSCs)** for retrieval, treatment, and storage of Operable Unit (OU) 7-10 (also known as Pit 9) waste-zone materials. Potential hazards associated with similar operations for other transuranic (TRU) pits and trenches in the Subsurface Disposal Area (SDA) will be considered (see Figure 1-1). Project management, design, and engineering can use this information as a basis to make informed decisions while incorporating safety features in the conceptual design.

This hazard identification document does not take the place of a preliminary safety analysis report or a hazard assessment document. The preliminary safety analysis report for the Stage III Project will be prepared during and after the conceptual design and will be submitted to U.S. Department of Energy (DOE) for approval before facility construction and the purchasing of facility components. Hazard categorization for the project will be documented in the preliminary safety analysis report; therefore, a hazard assessment document will not be required.

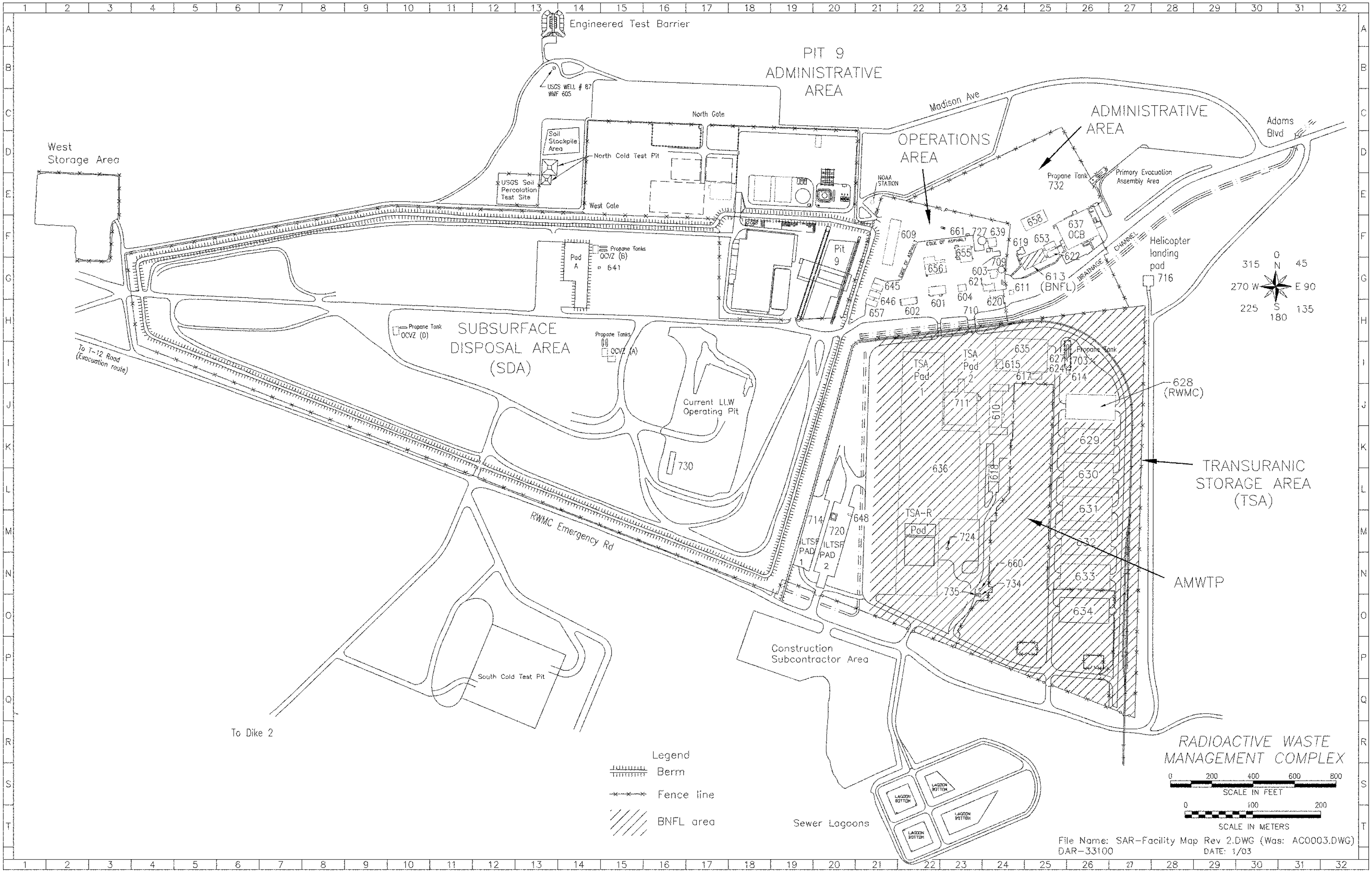


Figure 1-1 Location of Operable Unit 7-10 within the Subsurface Disposal Area at the Radioactive Waste Management Complex.

2. FACILITY DESCRIPTION

The mission of the OU 7-10 Stage III Project is to implement the *Record of Decision: Declaration of Pit 9 at the Radioactive Waste Management Complex Subsurface Disposal Area at the Idaho National Engineering and Environmental Laboratory'* for reducing the risk to the public and the environment posed by historical TRU waste disposal practices in the SDA. The OU 7-10 Stage III Project will be conducted as part of the Radioactive Waste Management Complex (RWMC) Closure Project, which supports the larger Idaho Completion Project. The Stage III system of facilities and equipment will be the means by which the OU 7-10 Stage III Project implements the interim action defined in the Record of Decision.'

At this stage in design, the system of facilities and associated retrieval and treatment processes is being identified through analysis of several options. Each of the retrieval and treatment options is discussed in the following sections.

2.1 Retrieval

All retrieval operations will be performed inside of a primary and secondary confinement. Retrieval of OU 7-10 will be performed in three basic layers: overburden, waste-zone material, and underburden. Each layer is handled separately, as practical, to minimize cross-contamination. Other activities to take place during retrieval include transferring waste for characterization, receiving waste that is acceptable for returning to the pit, sampling remaining underburden, and replacing removed overburden and underburden.

A layer of clean overburden first will be removed and staged. The middle overburden layer is staged inside containment. The lower overburden layer is sent to characterization. Then, the waste-zone materials and underburden will be excavated and delivered for sorting and characterization. The underburden will be replaced with clean soil from the spreading area or with removed overburden that meets acceptable criteria. Waste-zone materials and soils from characterization or treatment are returned to the pit followed by the return of clean overburden previously removed from the pit. Any remaining open volume in the pit is filled with clean soil from the Idaho National Engineering and Environmental Laboratory (INEEL) spreading area.

Three retrieval options are currently under evaluation. The primary differences in the options are the means that will be used to move excavated and refill materials. In general, equipment and structures for the selected retrieval operation will include, at least, excavating equipment, material-handling equipment, a primary confinement, a secondary confinement, and supporting utilities. Control of the spread of contamination will be optimized with water sprays, water mists, directed airflow, and filtration. The three retrieval options are summarized in Sections 2.1.1–2.1.3.

2.1.1 Backhoe and Crane Option

The pit is completely covered by a large confinement structure. The confinement structure is comprised of inner and outer skins. The inner skin forms the primary confinement, and the outer skin forms the secondary confinement. A remotely operated backhoe excavates from the top of the pit area inside the primary confinement. Soil excavated by the backhoe is placed in dirt hoppers, which are transported to the north end of the pit by the remote-controlled overhead crane and placed on an automatic guided vehicle (AGV). For the top layer of overburden, the AGV carries the hoppers out of the building, and a forklift is used to dump the hoppers. The hoppers are returned to the backhoe by the AGV and crane. For the middle overburden layer, the hoppers are carried directly by the overhead crane to the inside staging pile at the north end of the pit. The lower overburden layer, the waste material, and the underburden soil are excavated by the backhoe and placed in boxes, which are loaded onto the AGV by the overhead crane. The AGV delivers the boxes to the sorting deck where the contents are dumped and the boxes are returned for placement in the excavation.

Backfill of the pit begins by placing soil from the inside staging pile (middle layer of original overburden) in the bottom of the excavation. The soil is loaded by the backhoe into dirt hoppers, which are carried and dumped into the pit by the overhead crane. A remote-controlled compactor with a blade levels and compacts the soil to form the underburden base. A layer of clean gravel is added on top of this soil before the returned waste boxes are placed in the excavation. The gravel is brought into the primary confinement through a chute with an air lock and is spread with the dirt hopper, crane, and compactor. Returned waste boxes are placed on the gravel floor by the crane. The first overburden layer covering returned waste boxes is non-TRU soil from characterization. It is returned to the pit in dirt hoppers by way of the AGV and overhead crane. The soil is dumped on boxes in the excavation and is then leveled and compacted by the compactor. Soil from the overburden pile outside the confinement structure is brought into the primary confinement through the air lock chute by way of the dirt hoppers and spread and compacted by the compactor.

2.1.2 Backhoe and Forklift Option

This option is the same as the previous option except that the overhead crane function is replaced by a forklift. In order to reduce the amount of travel of the forklift, the AGV is programmed to travel along the west side of the pit. Therefore, the forklift delivers and receives boxes and dirt hoppers to and from the AGV along the side of the pit.

2.1.3 Front-End Loader Option

This option is similar to the previous option except that the front-end loader is used to excavate the top layer of overburden and the waste zone where layers will not intermingle. The front-end loader bucket also is used to transport materials, so the boxes, dirt hoppers, and AGV are not required. A backhoe is still used to excavate the two lower layers of overburden and the underburden, but the soil from these layers is piled by the backhoe and scooped and transported by the front-end loader. When the front-end loader places the underburden and overburden soil back into the pit, it also can level and compact them, removing the requirement for a compactor.

2.2 Treatment

Waste removed from the SDA will be segregated as TRU waste ($\geq$100 nCi/g) versus non-TRU waste, treated (as necessary), packaged, and either (1) certified and loaded for shipment to the Waste Isolation Pilot Plant (WIPP) for final disposal or (2) returned to the pit. Transuranic waste will be treated to meet the WIPP waste acceptance criteria and to reduce the life-cycle project costs, including waste characterization, packaging, transportation, and disposal costs. Non-TRU materials will be treated to meet the criteria established in the Record of Decision for OU 7-10.' At this time, the final treatment process has not been identified. However, at a minimum, the non-TRU waste presumably will be treated by thermal desorption to remove volatile organic compounds (VOCs) to meet preestablished concentration levels.

One of the basic design assumptions for treatment is that the treatment processes are to be designed based on contact-handled materials management protocol, and no materials >200 mR/hour at contact, shielded or unshielded, will enter the treatment facilities.

The following sections discuss the options that have been selected for more development and analysis. The options to be developed more fully are:

- >100 nCi/g material
  - Compaction
  - Melt all
  - Segregate, incinerate, thermal desorption, and leach.
- ≤100 nCi/g material requiring return to pit treatment
  - Thermal all
  - Segregate, thermal desorption.

Following retrieval, waste-zone materials are assayed. If assayed <100 nCi/g, the materials are returned to the pit after undergoing either the thermal all or segregate and thermal desorption treatment processes. If assayed ≥100 nCi/g, the materials will undergo the compaction; melt all; or segregate, incinerate, thermal desorption, and leach process.

2.2.1 Compaction

The materials are directed to a sorting operation. The sorting operation removes WIPP-prohibited items, such as aerosol cans, gas cylinders, and containers with free liquids; materials that would be difficult to size or shred; and materials, such as nitrate salts, uranium, mercury, or cyanide, that require special handling. It then separates debris (typically larger than 60 mm) from smaller material (designated soil).

After sorting, the debris undergoes size reduction in an inert atmosphere. The material is then repackaged in drums for compaction. Compaction is done under high pressure, and the debris void fraction is practically eliminated, resulting in a 66% volume reduction. This processing possibly could be done with limited facility enhancements to the Advanced Mixed Waste Treatment Project (AMWTP) compaction process. The packaged waste is then staged for shipment to WIPP.

The soil fraction is assayed and separated into TRU and non-TRU streams. The TRU stream is characterized and packaged for transportation to and disposal at WIPP. The non-TRU stream is treated to remove VOC contaminants (if required) and returned to the pit.

2.2.2 Melt All

For this option, the TRU contaminated material is sorted, shredded in an inert atmosphere, and melted in a high-temperature melter, which may use high voltage and high current. The slag from the melter is packaged in carbon steel drums, characterized, and prepared for transportation to WIPP. The off-gas from the melter is sent to an off-gas treatment system where the off-gas is scrubbed and vented to the atmosphere. The scrub solution is stabilized, repackaged, and disposed of as low-level waste (LLW).

The major unit operations in this process are the melter, a secondary combustion chamber (also called a thermal oxidizer), a quench and scrubber system to reduce off-gas temperature and remove particulate and other contaminants like hydrochloric acid, a selective catalytic reduction unit for NO_x abatement, high-efficiency particulate air filtration, granulated activated carbon (GAC) for removal of mercury vapor and other contaminants, hazardous-materials-release-monitoring systems, and a stabilization system for the scrubber blowdown.

Chemicals used in this system include:

- Propane for thermal oxidation
- Sodium hydroxide in the scrubber process
- Anhydrous ammonia in the selective catalytic reduction unit
- Cement in the scrubber stabilization process.

2.2.3 Segregate, Incinerate, Thermal Desorption, and Leach and Recovery

The recovered material is assayed and then segregated into >60-mm material or <60-mm material. The >60-mm material is sorted, shredded in an inert atmosphere, and sent to thermal treatment (an incinerator, steam reformer, or hydrogenation). The off-gas from thermal treatment is sent to an off-gas treatment system where the off-gas is scrubbed and vented to the atmosphere. The scrub solution is stabilized, repackaged, and disposed of as LLW. The ash from thermal treatment is repackaged and sent to WIPP.

The <60-mm material is sent to thermal desorption. The products from thermal desorption are VOCs and dry soil. The VOCs are sent to thermal treatment. The dry soil is sent to a leach and recovery process. Following leaching, the soil is stabilized and sent back to the SDA. The leachate is sent to the thermal treatment.

The major components of the incinerator system are the incinerator itself, a secondary combustion chamber (also called a thermal oxidizer), a quench and scrubber system to reduce off-gas temperature and remove particulate and other contaminants like hydrochloric acid, a selective catalytic reduction unit for NO_x abatement, high-efficiency particulate air filtration, GAC for removal of mercury vapor and other contaminants, hazardous-materials-release-monitoring systems, and a stabilization system for the scrubber blowdown.

Chemicals used in the incinerator system include:

- Propane for the incinerator and secondary combustion chamber
- Sodium hydroxide in the scrubber process
- Anhydrous ammonia for the selective catalytic reduction process
- Cement and lime for scrubber stabilization

The major thermal desorption process unit operations consist of a rotary dryer, condenser, organic water separator, and GAC beds. No hazardous chemicals are added to the process in this system, but the volatile organics, such as carbon tetrachloride (CCl_4), 1,1,1 trichloroethane, trichloroethylene, and perchloroethane, in retrieved materials will be separated, condensed, and handled as liquids. Heat transfer fluids are used in various points in the process, but they are expected to be nonhazardous. Heat will be provided by electrical or propane heaters.

Chemical leaching operations include leaching with nitric acid, filtration, actinide precipitation, evaporation of process solutions, and drying of the soil. The actinide precipitation step involves neutralization of the nitric acid with sodium hydroxide and addition of oxalic acid to precipitate the TRU waste along with a variety of other metals. The chemical hazards associated with this system include:

- Nitric acid (13*M*)
- Oxalic acid
- Sodium hydroxide
- Propane (possibly as a heat source for dryers).

Other leach chemistries (such as ethylenediaminetetraacetic acid) and reducing agents such as hydroxylamine also might be used.

Treatment processes under consideration for non-TRU material include incineration and thermal desorption. The chemical hazards associated with these processes are the same as those discussed in Section 2.2.3 for the TRU materials.

2.2.4 Shred and Thermal All

The material is sorted, shredded in an inert atmosphere, and heat-treated. The heat treatment is incineration, steam reformation, or hydrogenation. The ash would be repackaged and sent to WIPP. All combustibles, volatiles, and water are removed from the material during this step. The off-gas is sent to off-gas treatment. The scrubbed off-gas is vented to the atmosphere. The scrub solution is stabilized. A cement grout is formed with a sodium chloride brine. The cement is repackaged and sent to a LLW facility.

2.2.5 Segregate and Thermal Desorption

The material is segregated into <60-mm material (Rocky Flats Plant [RFP] sludge and soil, greater than the trigger material) and ≥60-mm material. The ≥60-mm material is shredded in an inert atmosphere, repackaged, stabilized, and sent back to the pit.

The material <60 mm is sent to a thermal desorption unit. From this system, 100% of the organics are assumed sent to a GAC system. As described before, this assumes that 99% of the organics are sent off-Site. The dry soil from the thermal desorption unit is then repackaged, stabilized, and sent back to the pit.

3. HAZARD ANALYSIS

The purpose of this discussion is to present a preliminary analysis of potential operational, external, and natural event hazards that can affect the public, workers, and the environment. This analysis provides a predominantly qualitative evaluation of the spectrum of risks to the public, workers, and the environment from accidents involving any of the hazards identified.

3.1 Methodology

The hazard analysis process uses a systematic approach for identifying and evaluating hazards. The hazard analysis for this hazard identification document draws heavily on the results of hazard analysis results in previous safety analyses performed for operations at the RWMC. The *Radioactive Waste Management Complex Safety Analysis Report* (Addendum J)[2] provides results that are applicable to the excavation options. The *Advanced Mixed Waste Treatment Project Preliminary Safety Analysis Report* provides results that are applicable to most of the treatment options.[3] The RWMC *Safety Analysis Report* (SAR)[2] provides results that are applicable to waste-package handling, storage, nondestructive examination, and shipment. Therefore, the information provided in these safety analyses is referred to during the hazard analysis process.

3.1.1 Hazard Identification

The hazard identification includes an evaluation of other safety analyses performed at the RWMC, a search of the DOE Occurrence Reporting and Processing System (OWS) for occurrences at similar operations, consideration of the applicability and significance of hazards listed in a hazard identification checklist, and an evaluation of waste disposal records and reports and treatment option process flows to identify the applicable radioactive and nonradioactive hazardous materials.

Results of the analyses are presented in a hazard identification table, a table listing a sample of the applicable occurrences founding the OWS database, and a discussion of the results of the inventory analysis for OU 7-10 and the SDA as a whole. The hazards in the hazard identification table are grouped by operational, external, and natural events. The industrial safety and health hazards that are specifically controlled by compliance with occupational safety and health standards are identified and passed on for hazard evaluation if they are possible initiators for an uncontrolled exposure to radioactive or nonradioactive hazardous materials.

3.1.2 Hazard Evaluation

The results of the hazard identification are evaluated. The evaluation focuses on the development of the hazards into potential release and exposure scenarios, the identification of the risk of each scenario, the identification of the appropriate controls, and an analysis of the significance of these controls. The scenarios are grouped by operational, external, and natural event hazards. The likelihood of the initiator for each scenario is qualitatively estimated using the definitions in Table 3-1. No credit is taken for controls (design or administrative) that prevent the scenario. If there is uncertainty in the likelihood category, the higher frequency category is assumed.

A qualitative estimate of the potential unmitigated consequences to the off-Site public, collocated workers, facility workers, and the environment are made for each scenario using the consequence categories defined in Table 3-2. In making this estimate, no credit is taken for controls (design or administrative) that mitigate the scenario. If there was uncertainty in the consequence category, the more severe consequence category is assumed.

Table 3-1. Qualitative definitions of likelihood categories

Likelihood Category	Description	Frequency of Occurrence (annually)
Anticipated	Events that have occurred or are expected to occur during the lifetime of the facility (frequency between 1 in 10 and 1 in 100 years)	10^{-2}–10^{-1}
Unllkely	Events that may occur but are not anticipated in the lifetime of the facility (frequency between 1 in 100 and 1 in 10,000 years)	10^{-4}–10^{-2}
Extremely unlikely	Events that while possible will probably not occur in the lifetime of the facility (frequency between 1 in 10,000 and 1 in 1,000,000 years)	10^{-6}–10^{-4}
Beyond extremely unlikely	Events that are considered too improbable to warrant further consideration: incredible scenarios (frequency less than 1 in 1,000,000 years)	$<10^{-6}$

Table 3-2. Qualitative definitions of consequence categories.

Consequence Category	Off-Site Public”	On-Site[b] (Collocated) Workers	Facility Workers[c]	Environment
High (H)	>25 rem[d] or >ERPG-2[e]	>100 rem or >ERPG-3[e] or >Δ10 psi[f]	>100 rem or >ERPG-3[e] or >Δ10 psi[f]	Off-Site contamination or major liquid release to the groundwater
Moderate (M)	5–25 rem or ERPG-1[e] to ERPG-2[e]	25–100 rem or ERPG-2[e] to ERPG-3[e]	25–100 rem or ERPG-2[e] to ERPG-3[e]	On-Site contamination
Low (L)	0.5–5 rem or TLV–TWA[g,h] to EWG-1	5–25 rem or ERPG-1[e] to ERPG-2[e]	5–25 rem or ERPG-1[e] to ERPG-2[e]	Site area contamination outside the facility
Negligible (N)	<0.5 rem or <TLV–TWA[g,h]	<5 rem or <ERPG-1[e]	<5 rem or <ERPG-1[e]	No contamination outside the facility

a. The off-Site public is a hypothetical maximally exposed individual at the nearest Idaho National Engineering and Environmental Laboratory site boundary.
b. The on-Site (collocated) worker is located outside the facility and is assumed to be 100 m from the release or, for elevated or buoyant releases, at the point where the release reaches ground level.
c. The facility worker is inside the facility (e.g., in the immediate vicinity of the release).
d. Radioactive material exposures (rem) are total-effective-dose equivalent.
e. Emergency response planning guideline values are intended to provide estimates of concentration ranges where one might reasonably anticipate observing adverse effects, as described in the definitions of ERPG-1, ERPG-2, and ERPG-3, as a consequence of exposure to the specific substance.

- The ERPG-1 is the maximum airborne concentration below which it is hypothesized that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odor.
- The ERPG-2 is the maximum airborne concentration below which it is hypothesized that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual’s ability to take protective actions.
- The ERPG-3 is the maximum airborne concentration below which it is hypothesized that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects.

f. Explosion overpressure is expressed as the differential pressure (A psi) of the shockwave from a detonation.
g. The TLV-TWA is the TWA concentration for a normal 8-hour workday and a 40-hour workweek to which nearly all workers may be repeatedly exposed, day after day, without adverse effects.
h. If a TLV-TWA or EWG value for a specific substance has not been established, temporary emergency exposure limits are used. The ERPGs and temporary emergency exposure limits for specific chemicals are taken from *ERPGs and TEELs for Chemicals of Concern* (http://tis.eh.doe.gov/web/chemsafetv/teel.html).

EWG = emergency response planning guideline TLV–TWA = threshold limit value-time-weighted average

Based on the likelihood and consequences categories, risk bin numbers for radioactive and nonradioactive hazardous materials are assigned using the qualitative risk matrices in Figures 3-1, 3-2, and 3-3. Only one set of risk bin numbers will be shown if consequences of the radioactive and nonradioactive material exposures are about the same. There is no risk bin for environmental effects because environmental protection is not specifically addressed by the evaluation guidelines. The risk bin numbers in the risk matrices indicate whether safety **SSCs** (i.e., safety class or safety significant) should be considered in the design and whether technical safety requirements (TSRs) or other safety requirements should be considered for operations. The bases for qualitative frequency and consequence assessments for each of the scenarios (some are grouped under a common scenario heading) and a summary of the hazard analysis also are discussed.

3.2 Hazard Analysis Results

This subsection identifies the applicable hazards and includes the preliminary hazard categorization. The safety-significant SSCs and the major features for worker safety and protection of the environment are discussed, and unique and representative accidents are identified based on the results of this hazard evaluation.

3.2.1 Hazard Identification

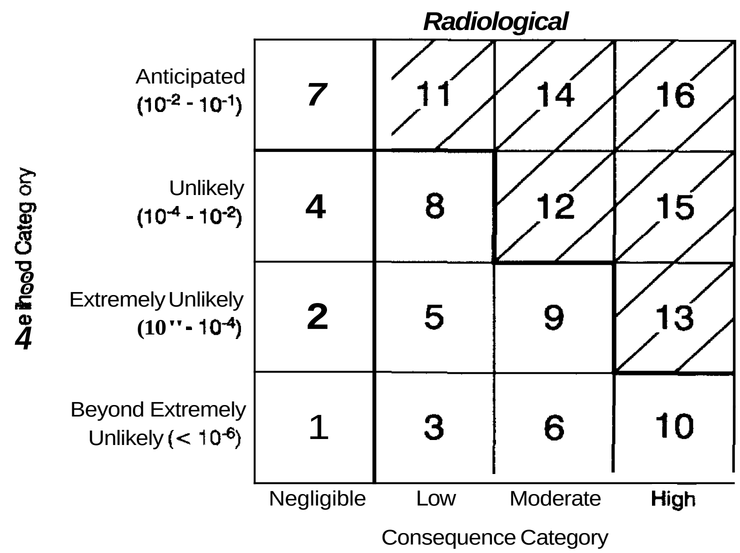
The following are the results of the hazard identification process described in Section 3.1.1.

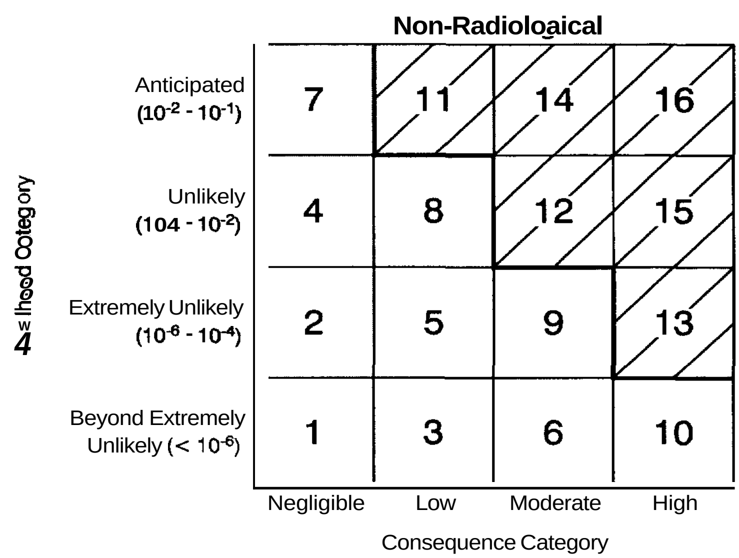
3.2.7.7 Occurrence Reporting and Processing System Database Search. The results of the OWS database search are summarized in Table 3-3. While this table does not list all applicable occurrences, it does list a sample of representative occurrences at plutonium-handling facilities. Included in the sample are breach of confinement, worker exposure, loss of contamination control, and loss of ventilation occurrences. There were no applicable occurrences found for fires and explosions involving plutonium. Fires and explosions involving plutonium facilities have occurred; however, these occurrences were before the OWS database was established.

3.2.1.2 Hazard Identification Checklist. Table 3-4 shows the results of the hazard identification checklist assessment for retrieval and treatment. The applicable hazards requiring additional analysis are: (1) operational—high and low voltages, high temperatures, high pressures, container overpressurization, mechanical and moving equipment, excavations, construction or demolition, compressed gases, material handling, combustible materials, flammable gases or liquids, pyrophoric metals, explosive materials, nonradioactive hazardous materials, ionizing radiation, radioactive materials, fissile materials, pit subsidence, and internal flooding; (2) external—aircraft impact, vehicle impact, range fires, impacts from collocated facilities, loss of electrical power, and pit subsidence; and (3) natural event—earthquake, flooding, high winds, lightning, snow loads, and volcanic eruptions.

3.2.1.3 Operable Unit 7-70 Inventory. A quantitative description of OU 7-10 and its contents is contained in *Pit 9 Estimated Inventory of Radiological and Nonradiological Constituents*.[4] Operable Unit 7-10 was used for disposal of radioactive and mixed radioactive waste from November **8,** 1967, to June 9, 1969. While OU 7-10 was operational, drums were generally dumped in the pit by truck or bulldozer. Large items were placed in the pit by crane. Approximately 250,000 ft^3 of overburden, 150,000 ft^3 of packaged waste, and 350,000 ft^3 of soil between and below the buried waste were in OU 7-10 at the time of closure. The pit was excavated to the basalt bedrock ranging between 13 and 21 ft in depth. Soil was placed over the bedrock to provide a level surface for placing the waste. This layer is expected to be up to several feet thick. Soil was placed over the waste with the intent of providing a 3-ft overburden layer. Because of maintenance for subsidence, the overburden layer is considered to vary between 2.5 ft and more than 5 ft, depending on the location.

Consequence Category	Off-Site Public
High (H)	greater than 25 rem **or** greater than ERPG-2
Moderate (M)	**5** rem to 25 rem *or* ERPG-1 **to** ERPG-2
Low (L)	0.5 rem to 5 rem **or** TLV-TWA to ERPG-1
Negligible (N)	less than 0.5 rem **or** **less than TLV-TWA**





KEY

Safety-class ***SSCs*** and/or TSRs should be identified to manage off-site public risk; accident analysis may be needed.

Safety-class SSCs or TSRs are generally not required to manage off-site public risk.

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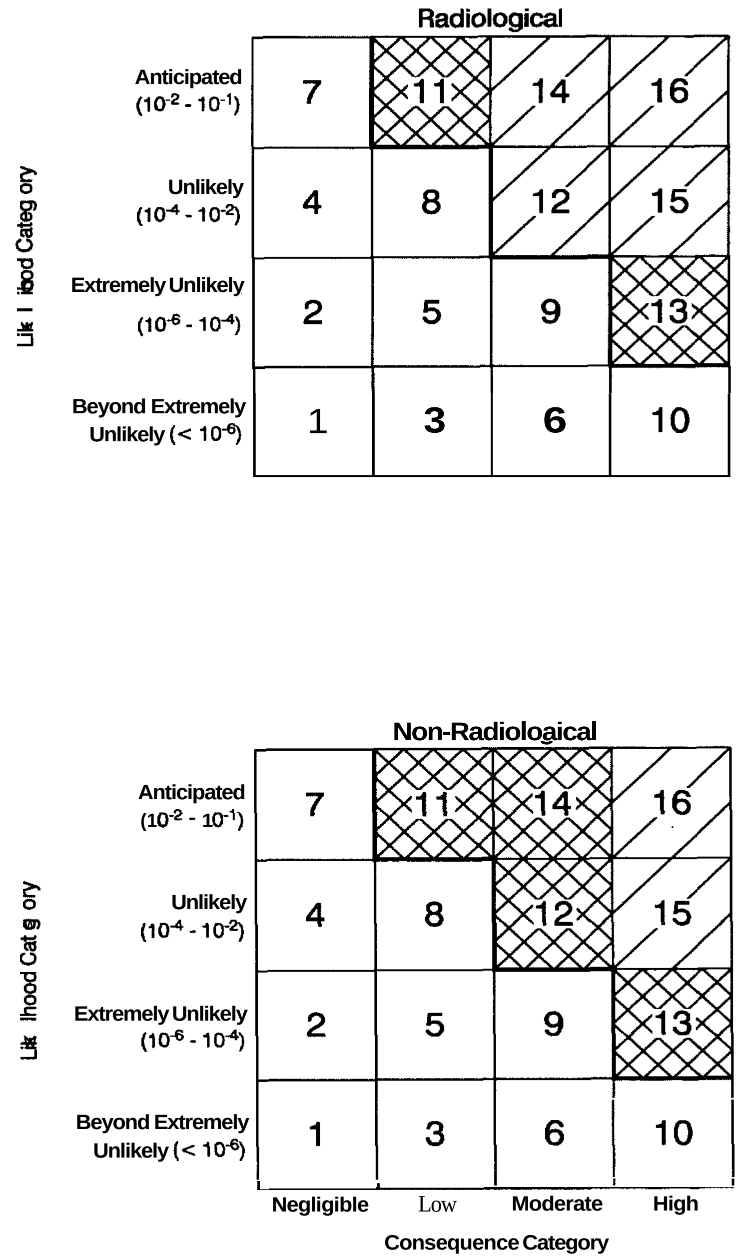
Figure 3-1. Qualitative risk matrices for the off-Site public.

Consequence Category	On-Site (Co-located) Workers
High (H)	greater than 100 rem or greater than ERPG-3 or greater than ▲10 psi
Moderate (M)	25 rem to 100 rem or ERPG-2 to ERPG-3
Low (L)	5 rem to 25 rem or ERPG-1 to ERPG-2
Negligible (N)	less than 5 rem or less than ERPG-1



KEY

Safety-significant SSCs and/or TSRs should be identified to manage co-located worker risk; accident analysis may be needed.

Safety requirements should be identified to manage co-located worker risk.

Safety *SSCs,* TSRs, or safety requirements are generally not required to manage co-located worker risk.

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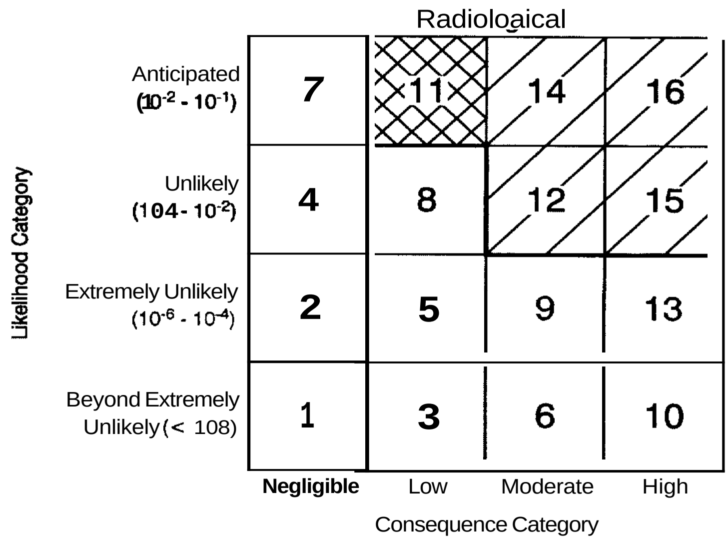
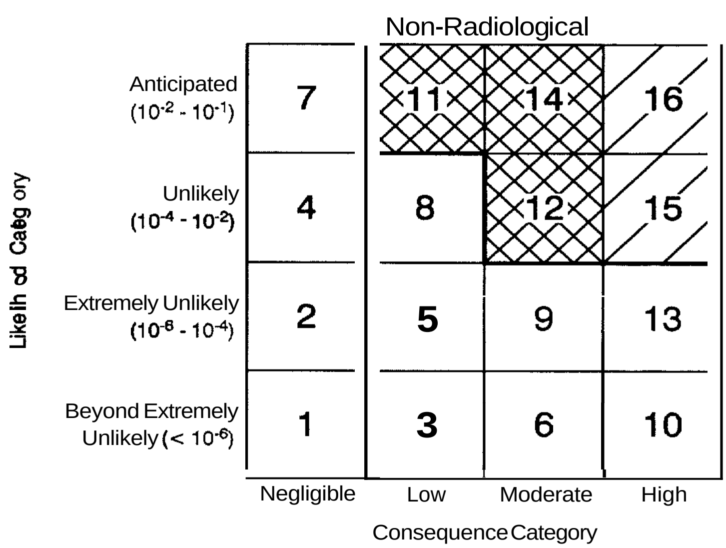
Figure 3-2. Qualitative risk matrices for collocated workers.

Consequence Category	Facility Workers
High (H)	greater than 100 rem or greater than ERPG-3 or greater than ▲10 psi
Moderate (M)	25 rem to 100 rem or ERPG-2 to ERPG-3
Low (L)	5 rem to 25 rem or ERPG-1 to ERPG-2
Negligible (N)	less than 5 rem or less than ERPG-1





K N

Safety-significant SSCs and/or TSRs should be identified to manage facility worker risk.

Safety requirements should be identified to manage facility worker risk.

Safety *SSCs,* TSRs, or safety requirements are generally not required to manage facility worker risk.

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Figure **3-3.** Qualitative **risk** matrices for facility workers.

Table 3-3. Representative and applicable scenarios from the U.S. Department of Energy Occurrence Reporting and Processing System database.

Report Number	Event Description	Safety Significance
ALA-LA-LANL-TA55-2000-0009	Failure of a Teflon gasket on a glovebox air lock results in an airborne release of Pu-238. The gasket failed because of radiation degradation and piping not adequately secured at one of the connections. Exposure estimates are 300 rem CEDE to one worker and <5 rem for three other workers.	Large worker doses are possible if glovebox materials are not resistant to degradation by radiation and if connections are not adequately secured.
ALO-LA-LANL-TA55-1997-0006	Complete loss of main electrical service and process ventilation at a plutonium-handling facility.	Loss of power scenarios should be considered for plutonium-handling facilities.
ALO-LA-LANL-TA55-1997-0020	The process exhaust ventilation for a plutonium processing and handling facility was lost because of adverse weather.	Loss of power scenarios should be considered for plutonium-handling facilities.
ALO-LA-LANL-TA55-1997-0036	Worker contamination and a CAM alarm because of a tear in a glovebox glove. The exposed worker had not inspected the glove before beginning work.	Glovebox glove tears can be a source for airborne releases.
ALO-LA-LANL-TA55-1999-0041)	During a glovebox glove changeout, a radioactive material release triggered a CAM. Analysis of the CAM filter indicated a maximum airborne concentration of 228 dpm/m^3 alpha.	Airborne releases are possible during glovebox glove changeouts.
ALO-LA-LANL-TA55-2000-0005	An employee at a plutonium-handling facility cut his finger while disassembling a sample cutter in a glovebox.	Contaminated wounds are possible in glovebox operations.
CH-BH-BNL-BNL-1999-0020	A fire occurred when a container of NaK was shredded exposing the NaK to the atmosphere. The heat from the reaction ignited combustible materials.	There is a potential for encountering pyrophoric materials at the SDA, and they could cause a fire if processed through the shredder.
HQ-GOPE-PETC-1992-0005	Incinerator being relit without first purging the vessel of fuel-rich gases caused a pressure pulse through the baghouse.	An incinerator overpressurization is possible if incinerator gases are not purged after a flameout.
ID-LITC-WASTEMNGT-1996-0012	During valve disassembly, approximately 1 qt of 13-*M* nitric acid spilled to the floor and surrounding piping. The mechanic was not wearing PPE and received an overexposure to NOx.	Acid spills are possible during maintenance activities. Therefore. PPE must be worn.
OH-FN-FFI-FEMP-1996-0075	Because of corrosion, approximately 3 tons of glass leaked from the melter.	Joule heating in a melter can cause corrosion of the melter and a release.
ORO-BNI-FUSRAPCISS-1996-0001	Experienced three flashes during thermal desorption process on oily waste in a 55-gal drum.	Demonstrates the capability for deflagrations to occur during thermal desorption processes.
ORO-BNI-FUSRAPCISS-1996-0001	Three flashes occurred during thermal treatment of an oily matrix for desorption of organic halides.	Fires could occur during treatment options involving thermal desorption.
ORO-MMES-Y12ENVRES-1994-0002	Approximately 88 gal of liquid leachate overflowed a 75,000-gal tank because of failure of a fill-limit device.	Process tank overflows during filling operations could occur in the leaching treatment option.

Table 3-3. (continued).

Report Number	Event Description	Safety Significance
RFO—KHLL-771OPS-2000-0012	A worker received positive results from a routine nasal smear after working in supplied air operations.	Worker exposures are possible if PPE is not in good condition or properly worn.
RFO-KHLL-7790PS-1999-0006	A worker was cutting in a glovebox when he accidentally hit the trigger on the electric saw and the blade cut through his gloves and into his finger. The CEDE dose was determined to be 3.1 rem and the maximum committed organ dose (bone surfaces) was 56 rem.	Contaminated wounds are possible in glovebox operations.
RL-PHMC-200LWP-1999-0010	Operator sprayed with 92% sulfuric acid because of chemical corrosion of a line. About 15 to 50 gallons of acid spilled. 1st and 2nd degree burns over 24% of the operators body.	Leaks and worker injuries are possible if leaching process lines are not resistance to chemical corrosion.
RL-PNNL-PNNLNUCL-1994-0062	The electrical insulation covering leads to the temporary meter start-up heaters caught fire.	A fire is possible if the melter support materials are combustible.
RL-PNNL-PNNLNUCL-1995-0005	A small fire ignited during compaction of low-level waste. Vapors from an aerosol can released during compaction were hypothesized to be the source of ignition.	There is a potential for encountering aerosol cans in the SDA. A fire could occur if processed through the compactor.
RL-WHC-ANALLAB-1991-1007	Because of poor sight glass quality, a nitric acid tank is overfilled and about 1 L of acid is spilled.	Spills during acid tank filling are possible.
SR-WSRC-HCAN-1998-0036	A carbon steel tap on a 4.6 molar nitric acid tank chemically corroded and leaked acid.	Leaks and worker injuries are possible if leaching process lines are not resistance to chemical corrosion.
SR-WSRC-RMAT-1996-0004	Molten glass leaked from the melter bottom drain plug result.	A failure in the melter could result in a release.
SR-WSRC-SUD-1995-0005	About 1 gal. 93% sulfuric acid leaked from a broken pipe and sprayed four employees. All four workers were wearing PPE but were still injured.	The process lines for the leaching option must be properly supported and resistant to breakage.
SR-WSRC-SUD-2001-0006	A fire occurred when ferrous materials were allowed to be introduced into the shredder, which created an ignition source (sparking in a dust filled atmosphere) within the shredder assembly.	Ferrous metals are buried at the SDA and could lead to a fire if processed through the shredder.
SR-WSRC-SUD-2002-0012	Improper unit head spacing in a shredder led to frictional heating and a fire.	Improper adjustment of the shredder could lead to a fiie.
SR-WSRC-TNX-1996-0001	Because of an instrument failure, a melter overheated, the melter shell was breached, and molten glass flowed through the breach.	Failure of a melter temperature control instrument could lead to melter damage and releases.
SR—WSRC-WVIT-1997-0020	Discovery of nonseismically qualified melter interlocks that prevent an explosion.	Potential explosion hazard and safety designation and qualification of melter safety systems.

CAM = continuous air monitor
CEDE = committed effective dose equivalent
NaK = sodium-potassium alloy
PPE = personal protective equipment
SDA = Subsurface Disposal Area

Table 3-4. Hazard identification checklist results.

Hazard Source	Hazard	Applicable	Explanation	U.S. Department of Energy-Prescribed Occupational Safety and Health Standards	Routine or Nonroutine and Significant
Operational	High voltage (2600 V)	Yes	Melter and thermal desorption unit	29 CFR 1910.137, .147, and Subpart S[5]; 29 CFR 1926 Subparts K and V[6]	Routine but significant as a potential initiator to a release
	Low voltage (<600 V)	Yes	Normal process voltages	29 CFR 1910.137, .147, and Subpart S: 29 CFR 1926 Subpart K	Routine but significant as a potential initiator to a release
	High-temperature (2125°F at contact or 2203°F) systems	Yes	Combustion engines, steam reformer, incinerator, melter, and thermal desorption unit	None of the DOE-prescribed OSH standards clearly address the hazards of high-temperature systems	Nonroutine and significant as a potential initiator to a release
	High-pressure (225 psig for gas or vapor or 2200 psig for liquid) systems	Yes	Compactor hydraulics, excavator hydraulics, forklift hydraulics, and process hydraulics	None of the DOE-prescribed OSH standards clearly address the hazards of high-pressure systems	Nonroutine and significant as a potential initiator to a release
	Container overpressurization	Yes	Radiolytic gases and reactions in chemical process tanks	None of the DOE-prescribed OSH standards clearly address the hazards of container overpressurization	Nonroutine and significant as a potential release initiator
	Mechanical and moving equipment	Yes	Compactor, shredder, feed augers, conveyors, pumps, electric motors, excavator, forklifts, and trucks	29 CFR 1910.147 and .211 to .219; 29 CFR 1910 Subparts O and P; 29 CFR 1926 Subparts N, O, and W	Routine but significant as a potential initiator to a release
	Working at heights	Yes	Normal operations	29 CFR 1910 Subparts D and F; 29 CFR 1926.104, .105, and Subparts L, M, and X	Routine and not significant as an initiator to a release
	Excavations	Yes	Retrieval operations	29 CFR 1926 Subpart P	Routine but significant as a potential initiator to a release
	Construction or demolition	Yes	Facility construction and facility decommissioning, decontamination, and dismantlement	29 CFR 1926	Routine and significant as a potential initiator to a release
	Material handling	Yes	Drummovement, puck movement, waste-zone-material handling, and process chemical handling	29 CFR 1910.120, .176, and .178 to ,181: 29 CFR 1926.251 and Subpart N	Routine but significant as a potential initiator to a release

Table 3-4. (continued)

Hazard Source	Hazard	Applicable	Explanation	U.S. Department of Energy-Prescribed Occupational Safety and Health Standards	Routine or Nonroutine and Significant
	Compressed gases	Yes	Anhydrous ammonia, instrument gases, containers in waste-zone materials, and compressed plant and breathmg air systems	29 CFR 1910.101 and Subpart M	Routine but significant as a potential contributor to a release
	Combustible materials	Yes	Waste-zone materials and diesel fuel	29 CFR 1910 Subpart L; 29 CFR 1926 Subpart F	Routine but significant as a potential contributor to a release
	Flammable gases, liquids, or dust	Yes	Propane, hydrogen, and shredder operation dust	29 CFR 1910 Subpart H, .144, and ,1200; 29 CFR 1926.152	Routine but significant as a potential contributor to a release
	Pyrophoric metals	Yes	Zirconium, uranium, and Pu-52	None of the DOE-prescribed OSH standards clearly address the hazards of pyrophoric materials	Nonroutine and significant as a potential initiator to a release
	Explosive materials	Yes	Hydrogen in drums, propane in tanks, and nitrates and organics in thermal treatments	29 CFR 1910.109; 29 CFR 1926 Subpart U	Nonroutine and significant as a potential initiator to a release
	Inadequate illumination	Yes	Back shift operations	29 CFR 1910.37, .68, .110, .120, .177 to .179, .219, and .303; 29 CFR 1926.26	Routine and not significant as aninitiator to a release
	Cryogens	Yes	Anhydrous ammonia and liquid nitrogen for instruments	None of the DOE-prescribed OSH standards clearly address the hazards of cryogenics	Routine and not significant as an initiator to a release
	Nonradioactive hazardous materials	Yes	Waste-zone materials and process chemicals	29 CFR 1910.119, .120, ,1200, and Subpart Z; 29 CFR 1926.353 and Subparts D, E, and Z; ACGIH TLVs	Routine but potentially significant contributor to exposures
	Pesticide use	No	NA	29 CFR 1910.1200	NA
	Biological agents	No	NA	None of the DOE-prescribed OSH standards clearly address the hazards of biological agents	NA
	High noise levels	Yes	Combustion engines and process equipment	29 CFR 1910.95 and ,1200; 29 CFR 1926.52; ACGIH TLVs	Routine and not significant as an initiator to a release
	Inert or low-oxygen atmospheres	Yes	Shredder and process tanks	29 CFR 1910.120 and ,1200; 29 CFR 1926.651 and Subparts D and E	Routine and not significant as an initiator to a release

Table 3-4. (continued)

Hazard Source	Hazard	Applicable	Explanation	U.S. Department of Energy-Prescribed Occupational Safety and Health Standards	Routine or Nonroutine and Significant
	High-intensity magnetic fields	No	NA	ACGIH TLVs	NA
	Nonionizing radiation	Yes	Lasers in bar code readers	29 CFR 1910.97; 29 CFR 1926.54; ACGIH TLVs	Routine and not significant as an initiator to a release
	Ionizing radiation	Yes	Pu-52, uranium, Am-241, and Co-60	29 CFR 1926.53; ACGIH TLVs	Routine but significant as a potential contributor to exposures
	Fissile materials	Yes	Pu-52, Am-241, and uranium	None of the DOE-prescribed OSH standards clearly address the hazards of nuclear criticality	Nonroutine and significant as a potential contributor to on-Site exposures
	Pit subsidence	Yes	Retrieval work on pits	None of the DOE-prescribed OSH standards clearly address the hazards of pit subsidence	Nonroutine and significant as a potential contributor to on-Site exposures
	Internal flooding	Yes	Facility water lines	None of the DOE-prescribed OSH standards clearly address the hazards of internal flooding	Nonroutine and significant as a potential contributor to contamination spread
External	Aircraft impact	Yes	Over flights of commercial and military aircraft	None of the DOE-prescribed OSH standards clearly address the hazards of impacts by aircraft	Nonroutine and significant as a potential initiator to a release
	Vehicle impact	Yes	Plant trucks and forklifts	29 CFR 1910.178	Nonroutine and significant as a potential initiator to a release
	Range fires	Yes	Dry brush and grass near and in Radioactive Waste Management Complex	None of the DOE-prescribed OSH standards clearly address the hazards of range fires	Nonroutine and significant as a potential initiator to a release
	Impacts from collocated facilities	Yes	Advanced Mixed Waste Treatment Project	None of the DOE-prescribed OSH standards clearly address impacts from collocated facilities	Nonroutine but not significant as a potential initiator to a release
	Loss of electncal power	Yes	Commercial and Idaho National Engineering and Environmental Laboratory power grids	None of the DOE-prescribed OSH standards clearly address the hazards of a loss of electncal power	Nonroutine and significant as a potential initiator to a release
	Pit subsidence	Yes	Pits external to retrieval	None of the DOE-prescribed OSH standards clearly address the hazards of pit subsidence	Nonroutine and significant as a potential contributor to on-Site exposures
Natural event	Earthquake	Yes	Near seismically active region	None of the DOE-prescribed OSH standards clearly address the hazards of earthquake scenarios	Nonroutine and significant as a potential initiator to a release
	Flooding	Yes	Snow melt, rain, Lost River, and Mackey Dam	None of the DOE-prescribed OSH standards clearly address the hazards of flooding	Nonroutine and significant as a potential initiator to a release

Table 3-4. (continued)

Hazard Source	Hazard	Applicable	Explanation	U.S. Department of Energy-Prescribed Occupational Safety and Health Standards	Routine or Nonroutine and Significant
	High winds	Yes	Windy region	None of the DOE-prescribed OSH standards clearly address the hazards of high winds	Nonroutine and significant as a potential initiator to a release
	Tornadoes	No	NA	None of the DOE-prescribed OSH standards clearly address the hazards of tornadoes	Design for tornado hazards not required (see DOE-STD-1020-2002[7])
	Temperature extremes	Yes	Hot summer months and cold winter months	29 CFR 1910.120 and ,1200; ACGIH TLVs	Routine and not significant as an initiator to a release
	Lightning	Yes	Active lightning region	None of the DOE-prescribed OSH standards clearly address the hazards of lighting	Nonroutine and significant as a potential initiator to a release
	Snow loads	Yes	Snowy region	None of the DOE-prescribed OSH standards clearly address the hazards of snow loads	Nonroutine and significant as a potential initiator to a release
	Volcanic eruption	Yes	Volcanic region	None of the DOE-prescribed OSH standards clearly address the hazards of a volcanic eruption	Nonroutine and significant as a potential initiator to a release

ACGIH = American Conference of Governmental Industrial Hygienists
CFR = *Code of Federal Regulations*
DOE = U.S. Department of Energy
OSH = occupational safety and health
Pu-52 = weapons-grade plutonium
STD = standard
TLV = threshold limit value

The waste in OU 7-10 is primarily TRU waste generated at the RFP, totaling 110,000 ft^3, with additional waste from generators located at the INEEL, totaling 40,000 ft^3 and consisting of low-level waste.

Waste from RFP consisted primarily of drums of Series 74 sludge, secondary wooden boxes of assorted waste, and cardboard cartons containing empty contaminated drums. Shipping records indicate that there were two thousand seventy-seven 55-gal drums of RFP Series 74 sludge buried in OU 7-10.

Assorted waste was trucked from seven INEEL generators and buried in OU 7-10: Argonne National Laboratory-West, Central Facilities Area, Chemical Processing Plant, Naval Reactors Facility, Special Power Excursion Reactor Test Program, Test Area North, and Test Reactor Area. The low-level waste was brought and disposed of by various means (e.g., dumpster, boxes, pallets, and large components).

Waste containers likely will be in very poor condition because of disposal practices, flooding in 1969, and corrosion. This assumption is verified by the results of early retrieval efforts performed at the SDA in the late 1970s,[8] which showed that many of the drums were corroded and damaged, and the analysis of corrosion rates for drums, which indicates that few if any drums will be found intact.[9] The 1970 retrieval efforts' also showed that the wood-based containers disintegrated. Based on this information, it is assumed that most of the drums and all of the cardboard and wood boxes have lost structural integrity and that their contents are in direct contact with adjacent interstitial soils.

3.2.1.3.1 Operable Unit ***7-10*** Radioactive Material Inventory — Five radionuclides (Pu-238, Pu-239, Pu-240, Pu-241, and Am-241) composed 99.9% of the TRU radioactivity at the time of disposal in OU 7-10.[4] The combination of these radionuclides in weapons-grade plutonium is referred to as Pu-52. Assuming no decay, the weight fractions of the isotopes in Pu-52 are Pu-238, 0.00012; Pu-239, 0.93826; Pu-240, 0.05820; Pu-241, 0.00340; and Pu-242, 0.00024. As time passes, the short-lived Pu-241 (half-life of 14.4 years) undergoes beta decay to Am-241, adding slightly to the Am-241 inventory, and to very small quantities of Np-237. Operable Unit 7-10 also contains the following isotopes: U-234, U-235, and U-238. Other categories of radionuclides in OU 7-10 are mixed activation products and mixed fission products. Cobalt-60 is the dominant mixed activation product, and Cs-137, Ba-137m, Sr-90, and Y-90 are the dominant mixed fission products. A 40-year decay on the inventory was calculated to approximate the Curies for each of the isotopes at the time of retrieval (see Table 3-5).

Some uncertainties about the radioactive inventory exist; therefore, several sources of information are used to determine the most conservative unlikely and bounding inventories. These include an evaluation of shipping records, nondestructive examination data on aboveground waste, inventory database evaluation, and Stage I probe data.

A nonparametric statistical analysis of Stored Waste Examination Pilot Plant examination data and the Transuranic Reporting Inventory and Processing System database for aboveground waste has been completed.''The objective of the analysis is to estimate a reasonable upper bounding radionuclide content for drums in storage, based on the analysis of a representative set of drums. Rather than developing an inventory for each content code, the statistical analysis develops upper bounding contents for the general population of RFP waste drums. The results of the analysis are presented as a percent confidence level that a percentage of the drums encountered will be less than a Pu-239 equivalency. From this analysis, there is a 95% confidence that 99% of the general population of RFP waste drums will have less than 31.8 equivalent Ci of Pu-239, which is equal to approximately 510 g of Pu-239. The quantity represents the most conservative unlikely inventory.

Table 3-5. Total activities for radioactive contaminants in Operable Unit 7-10 decayed to 40 years (1969–2009).

Radionuclide	Original (Ci)	Half-Life (Year)	Decayed (Ci)
Am-241	3.20E+03	4.32E+02	3.30E+03
Ba-137m	5.80E-01	4.80E-05	2.19E-01
C-14	3.40E-04	5.73E+03	3.38E-04
Ce-144	4.20E-01	7.80E-01	0
Co-58	3.00E-03	1.94E-01	0
Co-60	1.20E+00	5.27E+00	6.23E-03
Cr-51	5.90E-01	7.59E-03	0
Cs-137	5.80E-01	3.02E+01	2.31E-01
Eu-154	8.80E-07	8.80E+00	3.77E-08
Eu-155	3.00E-03	2.73E+00	1.12E-05
Fe-55	1.10E+00	2.73E+00	3.81E-05
Mn-54	5.00E-03	8.57E-03	0
Nb-95	6.40E-02	9.75E-02	0
Ni-59	1.70E-04	7.60E+04	1.70E-04
Ni-63	1.30E-01	1.00E+02	9.86E-02
Pr-144	4.20E-01	3.30E-05	0
Pu-238	5.00E+01	8.77E+01	3.65E+01
Pu-239	1.70E+03	2.41E+04	1.70E+03
Pu-240	3.90E+02	6.56E+03	3.88E+02
Pu-241	1.10E+04	1.44E+01	1.60E+03
Pu-242	2.00E-02	3.75E+05	2.00E-01
Rh-106	2.10E-01	1.01E+00	0
Ru-106	2.10E-01	9.50E-07	0
Sb-125	9.10E-02	2.77E+00	4.09E-06
Sr-90	3.50E-01	2.86E+01	1.33E-01
Tc-99	5.50E-05	2.13E+05	5.50E-05
U-234	7.50E-01	2.46E+08	7.55E-01
U-235	5.30E-02	7.04E+08	5.31E-02
U-238	4.00E+00	4.47E+09	4.00E+00
Y-90	3.50E-01	1.20E-04	1.33E-01
Zr-95	6.40E-02	1.75E-02	0

Data from RadDecay[11]

Data collected from the Stage I probes indicate that there is a high concentration of fissile material at Probe P9-20. Analysis of the data collected from Probe P9-20 indicates that there could be as much as 2,217 fissile grams equivalent at this location.[12] This value represents the worst-case inventory condition and is very conservative.

According to shipping records, almost all waste disposals were within the contact dose rate requirement of ≤200 mR/hour of gamma radiation established at RWMC. Fourteen disposals were equal to or greater than 200 mR/hour at the time of disposal (see Table 3-6). Radioactive decay would decrease these dose rates substantially because Co-60 has a half-life of 5.26 years. The highest dose rate of 2,500 mR/hour shown in Table 3-6[4] would be about 13 mR/hour after 40 years of decay. From this discussion, it can be assumed that the ionizing radiation hazard from materials in OU 7-10 is minor.

3.2.1.3.2 Operable Unit ***7-10*** Nonradioactive Material Inventory — Table 3-7 lists the nonradioactive material inventory for OU 7-10. From this table, the dominant nonradioactive materials are in RFP waste and are CCl_4; tetrachloroethylene; 1,1,1 trichloroethane; and trichloroethylene found primarily in Series 743 sludge drums (Content Code 003) and salts (nitrates) found primarily in Series 745 sludge drums (Content Code 005).

Organic setups (Content Code 003) were produced from treatment of liquid organic waste generated by various plutonium and nonplutonium operations at the RFP. The organic waste was mixed with calcium silicate to form a grease or pastelike material. Small amounts of Oil Dri absorbent were usually mixed with the waste. The distribution of organics in a nominal Series 743 sludge drum (Content Code 003) represents a blend of used liquids. This blend is stated as the following[13]:

- 47% lathe coolant (i.e., 56.5% CCl_4 and 43.5% Texaco Regal R&O 32 oil [a light machining oil])
- 10% degreaser solvent (1,1,1 trichloroethane)
- 43% miscellaneous organics (i.e., 25% CCl_4 and 25% tetrachloroethylene, 25% trichloroethylene, 24.3% miscellaneous lubrication oils, and 0.7% Freon 113).

The average quantity of used liquid found in a Series 743 waste drum (Content Code 003) is 37 gal. The constituent percentage and quantity are listed below[13]:

- 37.3% (13.8 gal) CCl_4
- 20.4% (7.5 gal) Texaco Regal R&O 32 oil
- 10% (3.7 gal) 1,1,1 trichloroethane
- 10.8% (4 gal) tetrachloroethylene
- 10.8% (4 gal) trichloroethylene
- 10.4% (3.9 gal) miscellaneous lubrication oils
- 0.3% (0.1 gal) Freon 113.

For a bounding loading of a Series 743 sludge drum (Content Code 003), the 37 gal of used liquid are all assumed to be lathe coolant. The percentage and calculated quantity by constituent would be 56.5% (21 gal) CCl_4 and 43.5% (16 gal) Texaco Regal R&O 32 oil.[13]

Evaporator salts (Content Code 005) consist of salt residue generated from concentrating and drying liquid waste from solar evaporation ponds. The approximate chemical makeup of the salt is 60% sodium nitrate, 30% potassium nitrate, and 10% miscellaneous (i.e., sodium dichromate and potassium dichromate).[4] Portland cement was added to damp or wet salt when necessary.

Table 3-6. Operable Unit 7-10 waste with dose rates of 200 mR/hour or greater at the time of disposal.

Generator	Description	Characterization	Radiation Dose Rate at Disposal (mR/hour)	Radiation Dose Rate at Retrieval[a] (mR/hour)
Central Facilities Area	Bed of pickup	–90 ft^3, 275 lb	200	1.04
Chemical Processing Plant	Rags, sweepings, and blotting paper	204 ft^3, 850 lb, in 17 cardboard boxes	300	1.56
NRF-ECF	Excess steel storage rack	840 ft^3, 8,000 lb, wrapped in polyethylene	200	1.04
NRF-ECF	Degassifier collection tank containing solids	137 ft^3, 1.5 tons	800	4.16
NRF-ECF	Ducting from degassifier	250 ft^3, 1 ton, wrapped in polyethylene	250	1.30
NRF-ECF	Miscellaneous waste piping, wooden structure, and scrap metals	16 ft^3, 4,000 lb, wrapped in polyethylene	200	1.04
NRF-ECF	Dirt and scrap metal	81 ft^3, 9,000 lb, wrapped in polyethylene	2,500	13.2
NRF-ECF	Miscellaneous contaminated scrap and wooden boxes	550 ft^3, 1,500 lb	200	1.04
NRF-ECF	Paper, polyurethane, and cleanup material	204 ft^3, in 17 cardboard boxes	200	1.04
SPERT	Powder and granular UO_2 from one test fuel rod	0.25 ft^3, 1 lb, wrapped in plastic bag in cardboard box	200	1.04
SPERT	Powder and granular UO_2 from one test fuel rod	2 ft^3, 32 lb, wrapped in plastic bag in cardboard box	200	1.04
SPERT	Powder and granular UO_2 from one test fuel rod	2 ft^3, 32 lb, wrapped in plastic bag in cardboard box	200	1.04
Test Area North	Contaminated equipment from nuclear aircraft program	133 ft^3, 1 ton	250	1.30
Test Reactor Area	Contaminated metal and line	60 ft^3, 2,000 lb	200	1.04

a. Curies (1.50E+08 mR/Ci / disposal mR/hour) decayed for 40 years using RadDecay''
NRF-ECF = Naval Reactors Facility-Expended Core Facility
SPERT = Special Power Excursion Reactor Test

Table 3-7. Chemical inventory for Operable Unit 7-10.

Chemical	Content Code	Inventory (g)	Inventory (L)
Asbestos	335,338,490	4.0E+05	—
Ascorbic acid	004	1.4E+06	—
Beryllium	001	5.8E+04	—
Beryllium	002	1.9E+04	—
Beryllium (total)	001,002	7.7E+04	—
Butyl alcohol	001,002	1.1E+03	1.36E+00
Cadmium	001,002	5.4E+02	—
Carbon tetrachloride	001,002,003,004	9.4E+07	1.54E+04
Chloroform	001,002,003,004	1.6E+05	1.07E+02
ethylenediaminetetraaceticacid	004	1.4E+06	—
Ethyl alcohol	004	1.1E+06	1.39E+03
Freon 113	003	8.5E+05	1.42E+02
Lead	—	5.2E+06	—
Lithium oxide	002	Trace	—
Mercury	002	—[a]	—[a]
Methyl alcohol	004	2.2E+03	7.51E-01
Methyl alcohol	001,002	2.4E+03	8.01E-01
Methyl alcohol (total)	001,002	4.6E+03	1.55E+00
Methylene chloride	001,002,003,004	1.6E+05	1.20E+02
Nitrobenzene	Unknown	Trace	Trace
Picric Acid	INEEL waste	Unknown	—
Polychlorinatedbiphenyls	003	Unknown	Unknown
Potassium chloride	005	1.4E+06	—
Potassium &chromate	005	3.7E+04	—
Potassium cyanide	002	—[b]	—
Potassium nitrate	005	3.2E+07	—
Potassium phosphate	005	7.7E+05	—
Potassium sulfate	005	1.4E+06	—
Silver	INEEL waste	1.0E+00	—
Sodium chloride	005	3.0E+06	—
Sodium &chromate	005	7.8E+04	—
Sodium cyanide	002	—[b]	—
Sodium nitrate	005	6.5E+07	—
Sodium phosphate	005	1.4E+06	—
Sodium sulfate	005	3.0E+06	—
Tetrachloroethylene	003	2.7E+07	4.46E+03
1,1,1 trichloroethane	001,002,003,004	2.2E+07	4.17E+03
Trichloroethylene	003	2.5E+07	4.52E+03
Xylene	001,002	5.2E+03	5.98E+00
Zirconium	INEEL waste	1.5E+07	—

a. Pint bottles of mercury were periodically disposed of in the Series 742 sludge waste stream.[4] The amount of mercury in OU 7-10 is unknown.

b. Two 25-lb packs of sodium cyanide or potassium cyanide pellets were distributed in Series 742 sludge waste drums buried in the Subsurface Disposal Area.[4] It is assumed that the cyanide is in OU 7-10.

INEEL = Idaho National Engineering and Environmental Laboratory

3.2.1.3.3 Operable Unit 7-10 Flammable or Explosive Materials—From the evaluation in the *Fire Hazards Analysis for the OU 7-10 Glovebox Excavator Method Project*,[14] the majority of contents in OU 7-10 are noncombustible. However, nitration reactions and mixtures with free-flammable and -combustible liquids may have increased the flammability of the combustible materials. Flammable and combustible liquids, mainly oils in both damaged and intact containers, are expected. The pyrophoric metals that are present in massive form, specifically zirconium and zirconium alloy, do not pose a fire hazard. The uranium contaminants are expected to be either oxidized or dispersed in sludge material. The plutonium contaminants are expected to be oxidized. Thus, they do not pose a fire hazard unless modified during retrieval or treatment in a manner that exposes unoxidized material. The beryllium is expected to be in sludge form. As such, it is not expected to pose a fire hazard. Hydrogen is expected to be produced by the waste but is not expected to be present in sufficient concentrations during retrieval to present an explosion hazard.

3.2.1.4 Subsurface Disposal Area Inventory. To ensure consistency, Engineering Design File (EDF)-3543[15] was prepared to develop radioactive and nonradioactive material inventory information for use in writing safety analyses for the remediation of multiple pits or trenches at the SDA. Rather than developing pit- or trench-specific inventories as was done for OU 7-10, the EDF develops conglomerate radioactive and nonradioactive material inventories per drum and areal-drum densities at the SDA. The EDF addresses all waste types buried in the SDA, including TRU waste, contact-handled LLW, and remote-handled LLW. It also addresses nonradioactive hazardous materials that are part of the mixed TRU and LLW waste. The areas analyzed include the closed pits (Pits 1–16), the open pits (Pits 17–20), all trenches (Trenches 1–58), and all soil vault rows (Rows 1–21).

Table 3-8, Table 3-9, Table 3-10, and Table 3-11 list the results of inventory evaluations presented in EDF-3543.[15] These tables list the per-drum inventories, the areal densities of drums, and the approaches that will be used to identify the assumed radioactive and nonradioactive material inventories for hazard and accident analysis.

The SDA is known to contain 861 packages with surface radiation dose rates above 1 R/hour at the time of disposal. Sixteen of these dose rates were greater than 1,000 R/hour, and the largest was 150,000 R/hour. Appendix A of EDF-3543[15] contains a list, arranged by dose rate in descending order, of the high-radiation sources above 1 R/hour at the time of disposal in the pits and trenches at the SDA. The list was created by examining the shipping records for the SDA. Unknown isotopes in the list are hypothesized to be from Co-60, which has a half-life of 5.3 years. The dose rates in EDF-3543 are based on the decayed activity after 34 years. From EDF-3543, it can be determined that most high-radiation sources are from INEEL waste, and all but a few high-radiation waste sources are buried in the trenches rather than the pits. Sixty-seven of the packages have surface dose rates of 100 R/hour or greater, and the bounding surface dose rate is 24,000 R/hour.

The discussion in Section 3.2.1.3.3 for flammable and explosive materials in OU 7-10 is applicable for other pits and trenches at the SDA.

3.2.1.5 Process Chemicals. Depending on the treatment process selected, the process chemicals could include nitric acid, sodium hydroxide, anhydrous ammonia, oxalic acid, ethylenediaminetetraacetic acid, diesel, and propane. At this stage, the potential batch quantities of these chemicals required onsite to support operations have not been determined. Of these process chemicals, only anhydrous ammonia and nitric acid (if 95% greater by weight) have threshold quantities listed in 29 *Code of Federal Regulations* 1910.119[5] for performing process safety analyses for highly hazardous chemicals. The threshold quantities are 10,000 lb for anhydrous ammonia and 500 lb for nitric acid. There are no plans to use nitric acid at 95% or greater by weight.

Table 3-8. Per-drum inventories of transuranic waste at the Subsurface Disposal Area

Single-Drum Cases	Mass Content (g) Pu-239-equivalent	Mass Content (g) Am-241	Activity Content (Ci) Pu-239-equivalent	Activity Content (Ci) Am-241	Data Source
Upper bound drum (extremely unlikely)	2,217	71	140	240	Probe data for plutonium-equivalent acceptable knowledge for americium from T. L. Clements[16]
Limiting drum (unlikely)	510	31	31.8	105	EDF-2796[10] for plutonium-equivalent acceptable knowledge for amercium[16]
Average drum (anticipated)	58	0.22	3.6	0.74	EDF-2796 for plutonium-equivalent acceptable knowledge for americium

Notes:
Use either Pu-239-equivalent or Am-241 but not both. EDF-2796 includes Am-241 in calculating Pu-239 equivalent. For upper bound and limiting drums, finding both bounding inventories in the same drum is considered beyond extremely unlikely. An average drum would be expected to contain either Pu-239 equivalent or Am-241 but not both.
Plutonium-239-equivalent Curies were converted to grams using 0.062 Ci Pu-239-equivalent/g. Plutonium-239 equivalent from EDF-2796.[10]

EDF = engineering design file

Table 3-9. Transuranic inventory calculations for safety analyses at the Subsurface Disposal Area.

Large-Area-Inventory Cases	Transuranic Waste Inventory Calculation	Notes
Upper bound (extremely unlikely)	Upper bound drum content + (impacted area x maximum TRU drum areal density x average drum content)"	Upper bound drum content and average drum content from Table 3-5. Maximum TRU drum areal density = 0.83 drums/ft^2.
Limiting (unlikely)	Limiting drum content + (impacted area x median TRU drum areal density x average drum content)	Limiting drum content and average drum content from Table 3-5. Median TRU drum areal density = 0.29 drums/ft^2.
Average (anticipated)	Impacted area x median TRU drum areal density x average drum content	Average TRU drum content from Table 3-5. Median TRU drum areal density = 0.29 drums/ft^2.

a. Upper bound and average drum should be the same radionuclide (Pu-239 equivalent or Am-241). Use the radionuclide that produces the highest dose.

TRU = transuranic

Table 3-10. Bounding nonradioactive material densities at the Subsurface Disposal Area.

Contaminant	Upper Bound Inventory (g)	Bounding Inventory Density (g/drum)	Bounding Inventory Density (g/ft^2)	Average Inventory Density (g/drum)	Average Inventory Density (g/ft^2)
1,1,1 trichloroethane	1.2E+08	3.9E+04	1.4E+04	3.2E+02	1.7E+02
Freon 113	9.5E+06	3.1E+03	1.1E+03	2.5E+01	1.3E+01
2-butanone	4.0E+04	1.3E+01	4.6E+00	1.1E-01	5.6E-02
Acetone	1.3E+05	4.2E+01	1.5E+01	3.4E-01	1.8E-01
Aluminum nitrate nonahydrate	2.4E+08	7.7E+04	2.7E+04	6.4E+02	3.4E+02
Ammonia	1.8E+06	5.8E+02	2.1E+02	4.8E+00	2.5E+00
Anthracene	4.6E+02	1.5E-01	5.3E-02	1.2E-03	6.5E-04
Antimony	1.0E+03	3.2E-01	1.1E-01	2.7E-03	1.4E-03
Aqua regia	3.2E+01	1.0E-02	3.7E-03	8.5E-05	4.5E-05
Arsenic	1.1E+00	3.6E-04	1.3E-04	3.0E-06	1.6E-06
Asbestos	4.8E+06	1.5E+03	5.5E+02	1.3E+01	6.7E+00
Barium	1.2E+01	3.9E-03	1.4E-03	3.2E-05	1.7E-05
Benzine	4.8E+03	1.5E+00	5.5E-01	1.3E-02	6.7E-03
Beryllium	7.3E+07	2.4E+04	8.4E+03	1.9E+02	1.0E+02
Butyl alcohol	1.1E+05	3.5E+01	1.3E+01	2.9E-01	1.5E-01
Cadmium	2.3E+06	7.4E+02	2.6E+02	6.1E+00	3.2E+00
Carbon tetrachloride	8.2E+08	4.2E+04	1.5E+04	3.4E+02	1.8E+02
Cerium chloride	6.2E+05	2.0E+02	7.1E+01	1.6E+00	8.7E-01
Chloroform	3.7E+01	1.2E-02	4.2E-03	9.8E-05	5.2E-05
Chromium	1.6E+03	5.1E-01	1.8E-01	4.2E-03	2.2E-03
Copper	4.5E+04	1.5E+01	5.2E+00	1.2E-01	6.3E-02
Copper nitrate	4.1E+02	1.3E-01	4.7E-02	1.1E-03	5.8E-04
Ethylenediaminetetraacetic acid	1.4E+06	4.5E+02	1.6E+02	7.4E+01	3.1E+01
Ethyl alcohol	2.8E+04	9.0E+00	3.2E+00	7.4E-02	3.9E-02
Formaldehyde	1.5E+05	4.8E+01	1.7E+01	4.0E-01	2.1E-01
Hydrazine	2.3E+03	7.4E-01	2.6E-01	6.1E-03	3.2E-03
Hydrofluoric acid	9.4E+06	3.0E+03	1.1E+03	2.5E+01	1.3E+01
Lead	7.8E+08	2.5E+05	8.9E+04	2.1E+03	1.1E+03
Magnesium	1.1E+07	3.5E+03	1.3E+03	2.9E+01	1.5E+01
Magnesium fluoride	1.4E+05	4.5E+01	1.6E+01	3.7E-01	2.0E-01
Mercury	2.0E+06	7.1E+03	2.5E+03	5.2E+00	2.7E+00
Mercury nitrate monohydrate	1.0E+06	3.2E+02	1.1E+02	2.7E+00	1.4E+00
Methyl alcohol	2.5E+05	8.0E+01	2.9E+01	6.6E-01	3.5E-01

Table 3-10 (continued)

Contaminant	Upper Bound Inventory (g)	Bounding Inventory Density (g/drum)	Bounding Inventory Density (g/ft^2)	Average Inventory Density (g/drum)	Average Inventory Density (g/ft^2)
Methyl isobutyl ketone	1.1E+07	3.5E+03	1.3E+03	2.9E+01	1.5E+01
Methylene chloride	1.5E+07	4.8E+03	1.7E+03	4.0E+01	2.1E+01
Nickel	4.1E+03	1.3E+00	4.7E-01	1.1E-02	5.8E-03
Nitric acid	6.1E+07	2.0E+04	7.0E+03	1.6E+02	8.6E+01
Potassium chloride	9.1E+07	2.9E+04	1.0E+04	2.4E+02	1.3E+02
Potassium dichromate	3.0E+06	9.6E+02	3.4E+02	8.0E+00	4.2E+00
Potassium nitrate	2.4E+09	7.7E+05	2.7E+05	6.4E+03	3.4E+03
Potassium phosphate	1.3E+07	4.2E+03	1.5E+03	3.4E+01	1.8E+01
Potassium sulfate	9.1E+07	2.9E+04	1.0E+04	2.4E+02	1.3E+02
Silver	7.3E+03	2.3E+00	8.4E-01	1.9E-02	1.0E-02
Sodium	7.5E+04	2.4E+01	8.6E+00	2.0E-01	1.1E-01
Sodium chloride	1.8E+08	5.8E+04	2.1E+04	4.8E+02	2.5E+02
Sodium cyanide	1.9E+03	6.1E-01	2.2E-01	5.0E-03	2.7E-03
Sodium dichromate	5.4E+06	1.7E+03	6.2E+02	1.4E+01	7.6E+00
Sodium hydroxide	3.4E+02	1.1E-01	3.9E-02	9.0E-04	4.8E-04
Sodium nitrate	4.6E+09	1.5E+06	5.3E+05	1.2E+04	6.5E+03
Sodium phosphate	2.7E+07	8.7E+03	3.1E+03	7.2E+01	3.8E+01
Sodium potassium	2.3E+06	7.4E+02	2.6E+02	6.1E+00	3.2E+00
Sodium sulfate	2.1E+08	6.7E+04	2.4E+04	5.6E+02	2.9E+02
Sulfuric acid	1.5E+05	4.8E+01	1.7E+01	4.0E-01	2.1E-01
Terphenyl	1.0E+06	3.2E+02	1.1E+02	2.7E+00	1.4E+00
Tetrachloroethylene	9.8E+07	9.3E+03	3.3E+03	7.7E+01	4.1E+01
Toluene	2.5E+05	8.0E+01	2.9E+01	6.6E-01	3.5E-01
Tributyl phosphate	1.3E+06	4.2E+02	1.5E+02	3.4E+00	1.8E+00
Trichloroethylene	1.2E+08	3.9E+04	1.4E+04	3.2E+02	1.7E+02
Trimethylolpropane-triester	1.6E+06	5.1E+02	1.8E+02	4.2E+00	2.2E+00
Uranium	5.4E+08	1.7E+05	6.2E+04	1.4E+03	7.6E+02
Uranyl nitrate	2.8E+05	9.0E+01	3.2E+01	7.4E-01	3.9E-01
Xylene	9.8E+05	3.1E+02	1.1E+02	2.6E+00	1.4E+00
Zirconium	2.3E+07	7.4E+03	2.6E+03	6.1E+01	3.2E+01
Zirconium alloys	7.3E+06	2.3E+03	8.4E+02	1.9E+01	1.0E+01
Zirconium oxide	5.3E+03	1.7E+00	6.1E-01	1.4E-02	7.4E-03

Table 3-11. Calculating nonradioactive material inventories for safety analyses at the Subsurface Disposal Area.

Case and Likelihood Category	Single Drum	Area	Notes
Upper bound (extremely unlikely)	128 kg Carbon tetrachloride + bounding inventory (g/drum) for other contaminants	Upper bound single drum + bounding inventory density (g/ft^2) x impacted area (ft^2)	Upper bound single drum from second column. See text discussion of carbon tetrachloride.
Limiting (unlikely)	Bounding inventory (g/drum)	Bounding inventory density (g/ft^2) x impacted area (ft^2)	None
Average (anticipated)	Average inventory (g/drum)	Average inventory density (g/ft^2) x impacted area (ft^2)	None

3.2.2 Hazard Evaluation

This section presents the results of the hazard evaluation performed using the methodology described in Section 3.1. Table 3-12 lists the possible exposure scenarios for the operational, external, and natural event categories for each of the retrieval and treatment options.

3.2.2.1 Operational Scenarios. This group of events represents those hazards and their associated scenarios related to Stage III operations. All retrieval and treatment options selected to date are considered.

3.2.2.1.1 Breached Container — This scenario addresses breaches to boxes or drums of waste materials. The initiators for this scenario are usually related to human error or equipment malfunctions when handling the container. Therefore, the frequencies for these types of initiators are considered anticipated. The results of accident analyses in the RWMC SAR[2] for box and drum breaches indicate that the doses from radioactive and nonradioactive materials are within the negligible range for the collocated worker and off-Site public for anticipated release scenarios. The facility worker doses are qualitatively assessed to be within the low-consequence category for radioactive and nonradioactive hazardous materials. Safety SSCs and TSRs for this scenario are not required. A safety requirement is required for equipment-operator training.

3.2.2.1.2 Breached Confinements — This group of scenarios addresses breaches to confinements such as waste retrieval enclosures, gloveboxes, and enclosures around treatment systems. For clarity, each of the following breach scenarios is discussed separately:

- Equipment malhnction, frequency interference, or operator error. This scenario is from the safety analysis for the OU 7-10 Glovebox Excavator Method Project.[2] Addressed is confinement damage resulting in breaches caused by equipment malfunctions, such as a failure in hoisting and rigging equipment or material-handling equipment such as an excavator or forklift, their remote controls, or operator error. The frequencies for these types of initiators are generally within the anticipated range. An initiator that is unique for some remote-radio-controlled equipment such as a remote controlled excavator, front-end loader, or other material-handling unit is frequency interference or a frequency anomaly that results in a loss of control of the equipment. The results of hazard and accident analyses performed for the Glovebox Excavator Method Project indicate that consequences are negligible for the collocated worker and off-Site receptors and are moderate for the facility worker for radioactive and nonradioactive material releases from breaches of confinement from material-handling equipment. Because of the high risk to facility workers, the ventilation system is designated safety significant, and TSRs are required for equipment operator training, hoisting and rigging, and emergency preparedness programs.

Table 3-12. Hazard evaluation.

Hazard Source	Hazard Event	Activity	Initiator/Cause	Likelihood, Consequence, and Risk without Controls: Likelihood Category[a]	Likelihood, Consequence, and Risk without Controls: Consequence Category[b]	Likelihood, Consequence, and Risk without Controls: Risk Bin Number[c]	Preventive and Mitigative Controls: Design[d]	Preventive and Mitigative Controls: Administrative[e]
Operational	Breached container	Retrieval, treatment, and storage	Because of equipment failure or operator error, one or more waste containers are breached while handling.	Anticipated	Off-Site public: N Collocated workers: N Facility workers: L Environment: L	7 7 ***11*** —	Container design	***Operator training,*** emergency preparedness program, maintenance program, container liners, and handling procedures
	Breached confinement	Retrieval and treatment	a. Because of equipment malfunction, frequency interference, or operator error, a confinement is breached.	Anticipated	Off-Site public: N Collocated workers: N Facility workers: M Environment: N	7 7 ***14*** —	***Ventilation system***	***Operator training, hoisting and rigging program, emergency preparedness program,*** maintenance program, and monitoring
		Retrieval and treatment	b. An exhaust filter blowout, runaway fan, or plugged inlet filter results in increased pressure differentials and a breach of confinement.	Anticipated	Off-Site public: N Collocated workers: L Facility workers: M Environment: L	7 ***11*** ***14*** —	***Pressure relief system*** and pressure gauges	***Emergency preparedness program*** and maintenance program
		Retrieval and treatment	c. Waste-zone-material-handling results in a glove puncture and contaminated wound.	Anticipated	**<u>Radioactive</u>** Off-Site public: N Collocated workers: N Facility workers: L Environment: L **<u>Nonradioactive</u>** Off-Site public: N Collocated workers: N Facility workers: N Environment: N	 7 7 ***11*** — 7 7 7 —	Ventilation system and material compatibility	***Glove protection,*** glove inspections, monitoring, PPE, and the emergency preparedness program
		Retrieval and treatment	d. Confinement seals are compromised, and there is a leak.	Anticipated	Off-Site public: N Collocated workers: N Facility workers: N Environment: N	7 7 7 —	Ventilation system and material compatibility	Monitoring, PPE, and the emergency preparedness program
		Retrieval	e. Exhaust high-efficiency particulate air filters fail because of plugging.	Anticipated	**<u>Radioactive</u>** Off-Site public: N Collocated workers: L Facility workers: N Environment: L **<u>Nonradioactive</u>** Off-Site public: N Collocated workers: N Facility workers: N Environment: N	 7 ***11*** 7 — 7 7 7 —	Ventilation system design, pressure gauges, ducting, and filter housing	***Dust suppression*** and emergency preparedness program

Table *3*-12. (continued)

Hazard Source	Hazard Event	Activity	Initiator/Cause	Likelihood, Consequence, and Risk without Controls: Likelihood Category[a]	Consequence Category[b]	Risk Bin Number[c]	Preventive and Mitigative Controls: Design[d]	Administrative[e]
		Retrieval	f. A pit subsidence under the facility breaches confinements.	Anticipated	Off-Site public: N Collocated workers: L Facility workers: M Environment: L	7 ***11*** ***14*** —	***Structural design***	***Emergency preparedness program***
		Compaction	g. Compaction of pressurized gas cylinder in the compactor breaches compactor confinement.	Anticipated	**Radioactive** Off-Site public: N Collocated workers: N Facility workers: M Environment: L **Nonradioactive** Off-Site public: N Collocated workers: N Facility workers: L Environment: L	 7 7 ***14*** — 7 7 ***11*** —	***Confinement*** and ventilation system	***Waste segregation before compaction,*** operator training, and emergency preparedness program
		Compaction	h. Stroking of compactor displaces large amounts of air and pressurizes compactor confinement.	Anticipated	**Radioactive** Off-Site public: N Collocated workers: N Facility workers: M Environment: L **Nonradioactive** Off-Site public: N Collocated workers: N Facility workers: L Environment: L	 7 7 ***14*** — 7 7 ***11*** —	***Confinement*** and ventilation system	***Stroke speed*** and emergency preparedness program
		Incineration, thermal desorption, and melter	i. Thermal cycling on seals or penetrations results in a degradation of integrity.	Anticipated	**Radioactive** Off-Site public: N Collocated workers: N Facility workers: L Environment: L **Nonradioactive** Off-Site public: N Collocated workers: N Facility workers: M Environment: L	 7 7 ***11*** — 7 7 ***14*** —	Treatment system design, confinement, and ventilation	***Operator training,*** feed rate controls, maintenance and inspections, and emergency preparedness program

Table 3-12. (continued)

Hazard Source	Hazard Event	Activity	Initiator/Cause	Likelihood, Consequence, and Risk without Controls			Preventive and Mitigative Controls	
				Likelihood Category[a]	Consequence Category[b]	Risk Bin Number[c]	Design[d]	Administrative[e]
		Incineration, thermal desorption, and melter	j. Off-gas processing system is breached or fails.	Anticipated	**Radioactive** Off-Site public: N Collocated workers: L Facility workers: N Environment: N **Nonradioactive** Off-Site public: N Collocated workers: M Facility workers: N Environment: L	 7 ***11*** 7 — 7 ***14*** 7 —	***Control systems,*** off-gas processing system, and confinement	***Feed rate controls,*** emergency preparedness program, and maintenance and inspections
		Leaching	k. Acid or caustics in the leaching process are incompatible with process seals, and a release occurs.	Anticipated	**Radioactive** Off-Site public: N Collocated workers: N Facility workers: L Environment: N **Nonradioactive** Off-Site public: N Collocated workers: M Facility workers: H Environment: L	 7 7 ***11*** — 7 ***14*** ***16*** —	***Corrosion resistant materials*** and spill confinement	***Maintenance and inspection*** and emergency preparedness program
	Confinement entries	Retrieval and treatment	While in a confinement, a worker's PPE becomes damaged, is not working, or is not worn properly.	Anticipated	Off-Site public: N Collocated workers: L Facility workers: M Environment: N	7 ***11*** ***14*** —	None	***Radiation control, industrial hygiene,*** and emergency preparedness
	Ventilation system failure	Retrieval and treatment	Mechanical failure of the ventilation system results in a loss of airflow through confinements.	Anticipated	Off-Site public: N Collocated workers: N Facility workers: L Environment: N	7 7 ***11*** —	Confinement	***Maintenance and inspection*** and emergency preparedness
	Direct radiation	Retrieval	a. Excavating and handling highly radioactive waste from OU 7-10 results in unexpected exposures.	Extremely unlikely	Off-Site public: N Collocated workers: N Facility workers: H Environment: N	1 1 13 —	None	Monitoring, procedures, training, and emergency preparedness
		Retrieval	b. Excavating and handling highly radioactive waste from pits or trenches other than OU 7-10 results in unexpected exposures.	Anticipated	Off-Site public: N Collocated workers: N Facility workers: H Environment: N	7 7 ***16*** —	***Shielding***	***Radiation monitoring***, procedures, training, and emergency preparedness
	Excavation sloughing	Retrieval	Waste-zone materials slough off the excavation and create airborne releases.	Anticipated	Off-Site public: N Collocated workers: N Facility workers: M Environment: N	7 7 ***14*** —	***Confinement***	Safe angle of repose and emergency preparedness

Table 3-12. (continued)

Hazard Source	Hazard Event	Activity	Initiator/Cause	Likelihood, Consequence, and Risk without Controls: Likelihood Category[a]	Consequence Category[b]	Risk Bin Number[c]	Preventive and Mitigative Controls: Design[d]	Administrative[e]
	Criticality	Incineration, thermal desorption, and melter	a. Accumulation of fissile materials in ash or slag collection system and near-optimum conditions of geometry and moderation.	Unlikely	Off-Site public: N Collocated workers: M Facility workers: H Environment: L	—[f]	*Criticality alarm system*	*Assay and characterization, feed rate controls, free liquid control,* and *criticality control program*
		Retrieval	b. Accumulation of fissile materials and near-optimum conditions of geometry and moderation during the retrieval, and a criticality occurs.	Extremely Unlikely	Off-Site public: N Collocated workers: M Facility workers: H Environment: L	—[f]	*Criticality alarm system, container dimensions,* or *volume*	*Free liquid control, container-loading controls,* and *criticality control program*
		Sorting	c. Accumulation of fissile materials and near-optimum conditions of geometry and moderation during sorting and segregation.	Extremely Unlikely	Off-Site public: N Collocated workers: M Facility workers: H Environment: L	—[f]	*Criticality alarm system, container dimensions,* or *volume*	*Assay and characterization, container-loading controls, free liquid control,* and *criticality control program*
		Incineration, thermal desorption, and melter	d. Accumulation of fissile materials in wet scrub system of the off-gas system and near-optimum conditions of geometry and moderation.	Extremely unlikely	Off-Site public: N Collocated workers: M Facility workers: H Environment: L	—[f]	*Process design* and *criticality alarm system*	*Assay and characterization, feed controls, free liquid control,* and *criticality control program*
		Compactor	e. Accumulation and compaction of fissile materials in the compactor or a puck and near-optimum conditions of geometry and moderation.	Extremely unlikely	Off-Site public: N Collocated workers: M Facility workers: H Environment: L	—[f]	*Criticality alarm system*	*Assay and characterization, container-loading controls, free liquid control,* and *criticality control program*
		Shredder	f. Accumulation of fissile materials in shredder and near-optimum conditions of geometry and moderation.	Extremely unlikely	Off-Site public: N Collocated workers: M Facility workers: H Environment: L	—[f]	*Criticality alarm system*	*Assay and characterization, free liquid control, and criticality control program*
		Incinerator, desorption, melter, and shredder	g. Accumulation of fissile materials in augers and near-optimum conditions of geometry and moderation.	Extremely unlikely	Off-Site public: N Collocated workers: M Facility workers: H Environment: L	—[f]	*Criticality alarm system*	*Assay and characterization, free liquid control,* and *criticality control program*
		Leaching	h. Accumulation of fissile materials in leach process and near-optimum conditions of geometry and moderation.	Unlikely	Off-Site public: N Collocated workers: M Facility workers: H Environment: L	—[f]	*Process design* and *criticality alarm system*	*Assay and characterization* and *criticality control program*
		Retrieval and treatment	i. Overloaded container and near-optimum conditions of geometry and moderation.	Extremely unlikely	Off-Site public: N Collocated workers: M Facility workers: H Environment: L	—[f]	*Criticality alarm system*	*Assay and characterization, free liquid control, container-loading controls, and criticality control program*

Table *3*-12. (continued)

Hazard Source	Hazard Event	Activity	Initiator/Cause	Likelihood, Consequence, and Risk without Controls: Likelihood Category"	Consequence Category[b]	Risk Bin Number'	Preventive and Mitigative Controls: Design[d]	Administrative'
		Storage	j. Containers are overloaded with fissile material during treatment and near-optimum conditions of geometry and moderation during storage.	Beyond extremely unlikely	Off-Site public: N Collocated workers: M Facility workers: H Environment: L	—[f]	None	Assay and characterization, container storage limits, and criticality control program
	Energetic chemical reactions	Retrieval, compaction, shredding, and storage	a. Mixing incompatible waste-zone materials results in confinement overpressurization, fire, explosion, or release of toxic gases.	Extremely unlikely	Off-Site public: N Collocated workers: L Facility workers: M Environment: L	2 ***5*** 9 —	Ventilation system, confinement, and fire protection systems	Emergency preparedness
		Leaching	b. Excessive reaction heat and tank overpressurization during the leaching process.	Anticipated	**Radioactive** Off-Site public: N Collocated workers: N Facility workers: L Environment: N **Nonradioactive** Off-Site public: N Collocated workers: N Facility workers: M Environment: N	 7 7 ***11*** — 7 7 ***14*** —	***Acidfeed control system*** and confinement	Emergency preparedness
		Leaching	c. Excessive heat and tank overpressurization during the neutralization process.	Anticipated	**Radioactive** Off-Site public: N Collocated workers: N Facility workers: N Environment: N **Nonradioactive** Off-Site public: N Collocated workers: N Facility workers: M Environment: N	 7 7 7 — 7 7 ***14*** —	***Causticfeed control system*** and confinement	Emergency preparedness
	Fire	Retrieval, treatment, and storage	a. Repair activity (e.g., welding or cutting) causes fire in combustible material.	Anticipated	**Radioactive** Off-Site public: N Collocated workers: N Facility workers: L Environment: N **Nonradioactive** Off-Site public: N Collocated workers: N Facility workers: N Environment: N	 7 7 ***11*** — 7 7 7 —	Fire protection system and noncombustible containers	***Combustible material control*** and emergency preparedness

Table 3-12. (continued)

Hazard Source	Hazard Event	Activity	Initiator/Cause	Likelihood, Consequence, and Risk without Controls: Likelihood Category[a]	Consequence Category[b]	Risk Bin Number[c]	Preventive and Mitigative Controls: Design[d]	Administrative[e]
		Retrieval, treatment, and storage	b. Failure in a standard electrical system component or heater ignites combustible materials.	Anticipated	**Radioactive** Off-Site public: N Collocated workers: N Facility workers: L Environment: N **Nonradioactive** Off-Site public: N Collocated workers: N Facility workers: N Environment: N	 7 7 ***11*** — 7 7 7 —	***System design and installation,*** fire protection system, and noncombustible containers	Fire protection program, maintenance, and emergency preparedness
		Retrieval, treatment, and storage	c. A fuel spill is ignited. The fire breaches waste containers or a confinement system.	Unlikely	**Radioactive** Off-Site public: N Collocated workers: L Facility workers: M Environment: L **Nonradioactive** Off-Site public: N Collocated workers: N Facility workers: L Environment: N	 4 **8** ***12*** — 4 4 **8** —	Noncombustible containers and confinements	***Fire protection program, waste handling procedures, emergency preparedness program, operator training,*** and maintenance
		Retrieval	d. Large volume of combustible waste-zone material is ignited in the retrieval pit.	Unlikely	**Radioactive** Off-Site public: N Collocated workers: L Facility workers: M Environment: L **Nonradioactive** Off-Site public: L Collocated workers: H Facility workers: H Environment: M	 4 **8** ***12*** — **8** ***15*** ***15*** —	***Confinement,*** fire protection system, ventilation system, and selection of hydraulic fluids	***Fire protection program*** and ***emergency preparedness program***
		Incineration, thermal desorption, and melter	e. Contents of a feed hopper are ignited because of proximity to incinerator, desorption unit, or melter.	Anticipated	**Radioactive** Off-Site public: N Collocated workers: N Facility workers: L Environment: N **Nonradioactive** Off-Site public: N Collocated workers: N Facility workers: N Environment: N	 7 7 ***11*** — 7 7 7 —	***System design,*** fire protection system, confinement, and ventilation system	Fire protection program and emergency preparedness

Table 3-12. (continued)

Hazard Source	Hazard Event	Activity	Initiator/Cause	Likelihood, Consequence, and Risk without Controls: Likelihood Category[a]	Consequence Category[b]	Risk Bin Number[c]	Preventive and Mitigative Controls: Design[d]	Administrative[e]
		Shredding	f. Shredder operation results in a fire in combustible waste materials.	Anticipated	**Radioactive**		***Inert atmosphere,*** confinement, fire protection system, and ventilation system	Fire protection program and emergency preparedness
					Off-Site public: N	7		
					Collocated workers: N	7		
					Facility workers: L	***11***		
					Environment: N	—		
					Nonradioactive			
					Off-Site public: N	7		
					Collocated workers: N	7		
					Facility workers: N	7		
					Environment: N	—		
		Compaction	g. Compaction operation results in a fire in combustible waste materials in the compactor.	Anticipated	**Radioactive**		***Inert atmosphere,*** confinement, fire protection system, and ventilation system	Fire protection program and emergency preparedness
					Off-Site public: N	7		
					Collocated workers: N	7		
					Facility workers: L	***11***		
					Environment: N	—		
					Nonradioactive			
					Off-Site public: N	7		
					Collocated workers: N	7		
					Facility workers: N	7		
					Environment: N	—		
		Storage	h. Spontaneous ignition during storage in a new container containing waste.	Unlikely	**Radioactive**		Fire protection system	***Fire protection program, waste-handling procedures, emergency preparedness program,*** and ***operator training***
					Off-Site public: N	4		
					Collocated workers: N	4		
					Facility workers: L	**8**		
					Environment: N	—		
					Nonradioactive			
					Off-Site public: N	4		
					Collocated workers: M	***12***		
					Facility workers: H	***15***		
					Environment: M	—		
	Explosion	Retrieval and treatment	a. A flammable mixture of volatile organic compounds in a confinement such as a glovebox is ignited.	Beyond extremely unlikely	Off-Site public: N	1	Ventilation system and fire protection system	Emergency preparedness
					Collocated workers: L	**3**		
					Facility workers: H	***6***		
					Environment: L	—		
		Retrieval	b. A flammable mixture of gases accumulates in a buried drum and is ignited during retrieval.	Extremely unlikely	Off-Site public: N	2	Remote operations and fire protection systems	Inspection and puncturing of intact drums before handling and emergency preparedness
					Collocated workers: L	5		
					Facility workers: M	9		
					Environment: L	—		

Table 3-12. (continued)

Hazard Source	Hazard Event	Activity	Initiator/Cause	Likelihood, Consequence, and Risk without Controls: Likelihood Category[a]	Consequence Category[b]	Risk Bin Number[c]	Preventive and Mitigative Controls: Design[d]	Administrative[e]
		Retrieval	c. Hydrogen or methane gases produced by microbial action on buried waste are ignited during retrieval.	Beyond extremely unlikely	Off-Site public: N Collocated workers: L Facility workers: H Environment: L	1 **3** ***6*** —	Ventilation system, remote operations, and fire protection system	Emergency preparedness
		Incineration, thermal desorption, and melter	d. Damaged because of heating a pressurized gas cylinder.	Unlikely	Off-Site public: N Collocated workers: N Facility workers: L Environment: N	4 4 **8** —	Confinement	Sorting and emergency preparedness
		Incineration, thermal desorption, and melter	e. Overpressurization occurs because of reaction of nitrates and organics.	Unlikely	Off-Site public: L Collocated workers: M Facility workers: H Environment: M	**8** ***12*** ***15*** —	Confinement	***Sorting, feed rate controls,*** and emergency preparedness
		Incineration	f. Faults in incinerator fuel supply system results in excessive fuel flow and incinerator overpressurization.	Unlikely	Off-Site public: L Collocated workers: M Facility workers: H Environment: M	**8** ***12*** ***15*** —	***Incinerator fuel control system*** and ***confinement***	***Emergency preparedness***
		Incineration	g. Flameout of incinerator and restart results in incinerator overpressurization.	Unlikely	Off-Site public: L Collocated workers: M Facility workers: H Environment: M	**8** ***12*** ***15*** —	***Incinerator fuel control system*** and ***confinement***	***Incinerator restart procedures*** and ***emergency preparedness***
		Incineration	h. An accident results in a fire impinging on a propane tank and the eventual BLEVE of the tank.	Unlikely	Off-Site public: L Collocated workers: H Facility workers: H Environment: H	**8** ***15*** ***15*** —	***System designed to meet requirements of National Fire Protection Association 58***[17]	***Emergency preparedness program***
		Incineration, thermal desorption, and melter	i. Flammable off-gases accumulate in the unit or the unit off-gas treatment system and are ignited.	Unlikely	Off-Site public: N Collocated workers: L Facility workers: M Environment: L	4 **8** ***12*** —	***Systems designed to monitor and regulate combustion air temperatures or to control feed rates***	***Operating procedures*** and emergency preparedness
		Shredding	j. Shredder operation results in a dust-cloud explosion.	Unlikely	Off-Site public: N Collocated workers: L Facility workers: M Environment: L	4 **8** ***12*** —	***Inerting*** and confinement	Emergency preparedness
		Storage	k. A flammable mixture of gases accumulates in a stored drum and is ignited.	Unlikely	Off-Site public: N Collocated workers: L Facility workers: M Environment: L	4 **8** ***12*** —	Confinement	***Meet storage waste acceptance criteria for venting*** and emergency preparedness

Table 3-12. (continued)

Hazard Source	Hazard Event	Activity	Initiator/Cause	Likelihood, Consequence, and Risk without Controls			Preventive and Mitigative Controls	
				Likelihood Category[a]	Consequence Category[b]	Risk Bin Number[c]	Design[d]	Administrative[e]
	Drop	Compaction	a. A puck is dropped after compaction.	Anticipated	**<u>Radioactive</u>** Off-Site public: N Collocated workers: N Facility workers: L Environment: N	 7 7 ***11*** —	Confinement and ventilation system	***Operator training*** and emergency preparedness
					<u>Nonradioactive</u> Off-Site public: N Collocated workers: N Facility workers: N Environment: N	 7 7 7 —		
		Incineration, thermal desorption, and melter	b. A tote bin is dropped during transport.	Anticipated	**<u>Radioactive</u>** Off-Site public: N Collocated workers: L Facility workers: M Environment: N	 7 ***11*** ***14*** —	Confinement and ventilation system	***Operator training*** and emergency preparedness
					<u>Nonradioactive</u> Off-Site public: N Collocated workers: N Facility workers: L Environment: N	 7 7 ***11*** —		
	Spill	Retrieval and treatment	a. Waste-zone materials are spilled during packaging.	Anticipated	**<u>Radioactive</u>** Off-Site public: N Collocated workers: N Facility workers: L Environment: N	 7 7 ***11*** —	Confinement and ventilation system	***Operator training,*** procedures, PPE, monitoring, and emergency preparedness
					<u>Nonradioactive</u> Off-Site public: N Collocated workers: N Facility workers: N Environment: N	 7 7 7 —		
		Leaching	b. Because of equipment failure or human error, acid or caustic is spilled during a batch tank filling or maintenance operation.	Anticipated	**<u>Radioactive</u>** Off-Site public: N Collocated workers: N Facility workers: N Environment: N	 7 7 7 —	***Tank or pump design to prevent a large spill*** and spill confinement	***Operator training, remote filling operation,*** PPE, and emergency preparedness
					<u>Nonradioactive</u> Off-Site public: N Collocated workers: M Facility workers: H Environment: M	 7 ***14*** ***16*** —		

Table 3-12. (continued)

Hazard Source	Hazard Event	Activity	Initiator/Cause	Likelihood, Consequence, and Risk without Controls: Likelihood Category[a]	Consequence Category[b]	Risk Bin Number[c]	Preventive and Mitigative Controls: Design[d]	Administrative[e]
		Melting and leaching	c. Because of equipment failure or human error, anhydrous ammonia is spilled during a batch tank filling or maintenance operation.	Anticipated	**Radioactive** Off-Site public: N Collocated workers: N Facility workers: N Environment: N **Nonradioactive** Off-Site public: N Collocated workers: M Facility workers: H Environment: M	 7 7 7 — 7 ***14*** ***16*** —	***Tank or pump design toprevent a large spill*** and spill confinement	***Worker training, PPE, remotefilling operation,*** and emergency preparedness
	Flooding	Retrieval, treatment, and storage	a. Contaminated area flooding caused by a leak in, accidental contact with, or malfunctions of an internal water system.	Anticipated	Off-Site public: N Collocated workers: N Facility workers: N Environment: L	7 7 7 —	Fire protection system design	Maintenance and emergency preparedness
		Incineration, thermal desorption, and melter	b. Flooding results in thermal stress and failure of the incinerator, desorption unit, or melter.	Anticipated	**Radioactive** Off-Site public: N Collocated workers: N Facility workers: L Environment: L **Nonradioactive** Off-Site public: N Collocated workers: N Facility workers: M Environment: L	 7 7 ***11*** — 7 7 ***14*** —	***Flood control,*** confinement, and ventilation system	Emergency preparedness
External	Flooding	Retrieval, treatment, and storage	Flooding from a water line outside a facility.	Anticipated	Off-Site public: N Collocated workers: N Facility workers: N Environment: L	7 7 7 —	Fire protection system design	Maintenance and emergency preparedness
	Traffic	Retrieval, treatment, and storage	a. Vehicle impact with a facility results in a release.	Unlikely	Off-Site public: N Collocated workers: N Facility workers: L Environment: N	4 4 **8** —	None	Speed limit, operator training, emergency preparedness, and maintenance

Table 3-12. (continued)

Hazard Source	Hazard Event	Activity	Initiator/Cause	Likelihood, Consequence, and Risk without Controls			Preventive and Mitigative Controls	
				Likelihood Category[a]	Consequence Category[b]	Risk Bin Number[c]	Design[d]	Administrative[e]
		Leaching	b. Vehicle impact with batch chemical tanks results in a chemical spill.	Unlikely	**Radioactive** Off-Site public: N Collocated workers: N Facility workers: N Environment: N **Nonradioactive** Off-Site public: N Collocated workers: M Facility workers: H Environment: M	 4 4 4 — 4 ***12*** ***15*** —	***Impact barriers around tanks*** and spill confinement	***Emergency preparedness***
		Incineration	c. Vehicle impact with a propane tank results in a fire and BLEVE.	Extremely unlikely	Off-Site public: L Collocated workers: H Facility workers: H Environment: H	5 ***13*** 13 —	***Vehicle impact barriers***	Emergency preparedness
		Retrieval, treatment, and storage	d. An aircraft impact near or onto the facility.	Beyond extremely unlikely	Off-Site public: M Collocated workers: H Facility workers: H Environment: H	***6*** 10 10 —	None	Emergency preparedness
	Fire	Retrieval, treatment, and storage	a. An RWMC fire propagates to operations facilities.	Anticipated	Off-Site public: N Collocated workers: L Facility workers: M Environment: L	7 ***11*** ***14*** —	Confinements, fire-resistant construction, and fire-suppression systems	***Combustible material control*** and ***emergency preparedness program***
		Retrieval, treatment, and storage	b. A desert fire crosses the RWMC fence line and propagates to operations facilities.	Anticipated	Off-Site public: N Collocated workers: L Facility workers: M Environment: L	7 ***11*** ***14*** —	Confinements, fire-resistant construction, fire-suppression systems, and fire breaks	***Combustible material control*** and ***emergency preparedness program***
	Loss of electrical power	Retrieval and treatment	A loss of primary electrical power results in a loss of ventilation.	Anticipated	Off-Site public: N Collocated workers: N Facility workers: L Environment: N	7 7 ***11*** —	***Standby generator*** and confinements	Workplace monitoring and emergency preparedness
	Pit subsidence	Retrieval	Subsidence near but not under the facility.	Anticipated	Off-Site public: N Collocated workers: N Facility workers: N Environment: L	7 7 7 —	None	Emergency preparedness
Natural event	Lightning	Retrieval, treatment, and storage	Lightning strikes a facility and causes a fire.	Unlikely	Off-Site public: N Collocated workers: N Facility workers: L Environment: L	—[g]	Lightning protection, confinements, and fire-suppression systems	Fire protection program and emergency preparedness

Table 3-12. (continued)

Hazard Source	Hazard Event	Activity	Initiator/Cause	Likelihood, Consequence, and Risk without Controls: Likelihood Category[a]	Consequence Category[b]	Risk Bin Number[c]	Preventive and Mitigative Controls: Design[d]	Administrative[e]
	Volcanic activity	Retrieval, treatment, and storage	Lava flow or hot gases from a volcanic event breach containers and confinements.	Extremely unlikely	Off-Site public: N Collocated workers: H Facility workers: H Environment: M	—[g]	None	Emergency preparedness
	Earthquake	Retrieval, treatment, and storage	An earthquake results in a loss of power, breach of confinement, fires, incinerator explosion, and leaks from chemical batch tanks.	Unlikely	Off-Site public: L Collocated workers: H Facility workers: H Environment: H	—[g]	Structural design, spill confinement, fire-protection systems, and standby generator	Fire protection program and emergency preparedness
	High wind	Retrieval, treatment, and storage	High winds cause a loss of primary electrical power, pressurized confinements, damaged confinement, or a leak from chemical batch tanks.	Anticipated	Off-Site public: N Collocated workers: N Facility workers: L Environment: L	—[g]	Structural design, spill confinement, and standby generator	Emergency preparedness
	Snow load	Retrieval, treatment, and storage	Snow load collapses structures.	Anticipated	Off-Site public: N Collocated workers: N Facility workers: L Environment: N	—[g]	Structural design	Emergency preparedness
	Flood	Retrieval, treatment, and storage	Flooding of an excavation, treatment, or storage facility occurs because of surface water runoff or flooding of a river.	Unlikely	Off-Site public: N Collocated workers: N Facility workers: N Environment: M	—[g]	Idaho National Engineering Laboratory and Subsurface Disposal Area flood control system design	Emergency preparedness and maintenance of flood control system

a. The likelihood categories are listed and described in Table **3-1**

b. The consequence categories are denoted with the following: N-negligible, L-low, M-moderate, and H-high and are described in Table **3-2**

c. Risk bin numbers are highlighted in ***bold italics*** if they indicate that safety systems, structures, and components, technical safety requirements, or safety requirements should be identified to manage risk (see Figures **3-1, 3-2,** and **3-3).**

d. Systems, structures, and components designated as safety-class or safety-significant systems, structures, and components are highlighted in ***bold italics.***

e. Technical-safety-requirement-level controls or safety requirements are highlighted in ***bold italics.***

f. Risk bin numbers for criticality events are not developed because the engineering and administrative controls will always be safety significant and technical safety requirements.

g. Risk bin numbers for natural events are not developed because the facilities are either designed for the event or not.

BLEVE = boiling liquid-expanding vapor explosion
OU = operational unit
PPE = personal protective equipment
RWMC = Radioactive Waste Management Comulex

- **High-pressure differential.** This scenario is from the safety analysis for the OU 7-10 Glovebox Excavator Method Project.[2] This scenario involves damage to confinements because of high-pressure differentials created in the confinement by the ventilation system. The pressure differentials could be caused by an exhaust filter blowout because of high filter loadings, an equipment malfunction that creates a runaway fan condition, or plugging of an inlet filter. These types of initiators are considered anticipated. Consequences to the facility worker are moderate because of the size and energy of the breach. Consequences to the collocated worker are considered higher than other breach scenarios because of the potential to release unfiltered material through the ventilation stack. The high risk to the facility worker requires that a pressure relief system is present and that the system is safety significant. A TSR for an emergency preparedness program also is required.

- **Punctured glove.** This scenario is from the safety analysis for the OU 7-10 Glovebox Excavator Method Project.[2] The scenario envelopes glove tears and involves a glove breach and contaminated wound caused by sharp objects in the waste material. Sharp pieces of metal or glass could be in the waste materials; therefore, this is an anticipated event. There could be no risk to the off-Site public or collocated workers. Consequences to the facility worker would be limited exposure to radioactive materials in the wound. Consequences to the facility worker are assumed to be within the low-consequence category for exposure to radioactive materials and the negligible category for exposure to nonradioactive materials. Consequences to all other receptors are negligible. Safety SSCs and TSRs are not required. A safety requirement is required for glove protection when directly handling waste-zone materials.

- **Confinement seal leak.** This scenario assumes a small leak in confinement seals because of stresses on the seals created after construction, temperature changes in the confinement that result in seal shrinkage or hardening, degradation of seal materials by process or waste-zone material chemicals, or deformation caused by impact on the seals during operations. Assuming no prevention, any one of these initiators could be present during operations; therefore, the frequency for the scenario is assumed to be within the anticipated category. A small leak in confinement could only have negligible consequences for all the receptors. Safety SSCs, TSRs, or safety requirements are not required.

- **Filter failure.** The scenario is similar to the high-pressure differential scenario except that the differential pressures are only large enough to damage the exhaust high-efficiency particulate air filters. Other barriers of confinements are not damaged. The release is directed through the stack, and there is no exposure to the facility workers, but there could be an exposure to collocated workers. The initiators are within the anticipated category, and exposures to collocated workers are within the low-consequence category. The exposures to all other receptors are within the negligible category. Safety SSCs and TSRs are not required. A safety requirement for dust suppression to reduce filter loading during retrieval is identified.

- **Pit subsidence.** This scenario is from the safety analysis for the OU 7-10 Glovebox Excavator Method Project.[2] The scenario involves a pit subsidence under the retrieval facility. Pit subsidences are common occurrences at the SDA and are within the anticipated range of frequencies. Consequences for this scenario would be the same as for a large breach of confinement discussed in the equipment malfunction, frequency interference, or operator error scenario. Because of the high risk to the facility workers, the structural design features that protect confinements are safety significant, and the emergency preparedness program will be addressed by a TSR.

- **Compacting pressurized containers.** This scenario is from the *Preliminary Safety Analysis Report* (PSAR) for the AMWTP.[3] Compaction of a compressed gas cylinder or other pressurized container could have the potential to release materials. The initiator would be human error in placing prohibited items in the compactor. Therefore, the frequency of the initiator is anticipated. The consequence assessment assumes that a single drum of waste is being compacted, that a worker is standing near the compactor, and that the overpressurization event results in material releases outside the compactor. It is also assumed that the hazard from the radioactive materials is greater than the hazard from nonradioactive materials. The facility worker dose is moderate for radioactive materials and low-nonradioactive materials. Consequences to all other receptors are negligible. Because of potential high risk to the facility worker, the compactor confinement is safety significant, and a TSR is required for performing material screening segregation before compacting.

- **Compactor pressurization.** This scenario is from the PSAR for the AMWTP.[3] In this scenario, the compactor is overpressurized by the strokes of the compactor ram. The frequency and consequences for this event are identical to compacting a pressurized container; however, the controls are not. The compactor confinement is safety significant, and a TSR control is required to control the stroke speed.

- **Thermal cycling of incinerator, desorption unit, or melter.** This scenario is from an incinerator scenario in the PSAR for the AMWTP.[3] Frequent uncontrolled heat-up and cool-down cycles could result in a degradation of the incinerator, desorption unit, or melter structure. Thermal cycling may be caused by human error in performing the heat-up and cool-down procedures or by a flaw in the design or construction of the system. These types of initiators are within the anticipated range of frequencies. For this scenario, the hazard from gases created during treatment of nonradioactive materials such as chlorinated hydrocarbons is considered more significant that the hazards of radioactive materials. The effects of the leaks would be fairly localized so consequences to the facility worker are moderate for nonradioactive materials, low for radioactive materials, and negligible for all other receptors. Safety SSCs and TSRs are not required. A safety requirement is identified for operator training to ensure that the thermal treatment system is operated according to the manufacture specifications.

- **Off-gas treatment system failure.** This scenario is from the PSAR for the AMWTP.[3] A failure in the incinerator, desorption, or melter off-gas treatment system results in untreated effluents through the facility stack. The failure is assumed to be in the gas treatment system rather than the filtering system. (A failure in the filtering system is addressed in a previous scenario.) The frequency assessment assumes that only one failure in the system could result in a release. Therefore, the scenario initiator is anticipated. Analysis of the actual system design could demonstrate that multiple failures are required, in which case the frequency could be reduced. Since the release is through the stack, the only possible receptors are collocated workers and the off-Site public. Until actual off-gas analyses are performed, it is assumed that consequences to the collocated worker are moderate and that consequences to the off-Site public are negligible. Safety SSCs and TSRs are not required. Safety requirements are identified for an off-gas control system and for system feed rates that would limit the release of untreated materials through the stack.

- **Breach in process line.** This scenario considers a degradation of materials in process lines, tanks, or equipment caused by corrosion from leach process chemicals. The scenario is anticipated since the initiating event is human error in specifying the correct materials. Consequences from nonradioactive materials would likely be higher than from the radioactive materials. For nonradioactive materials, consequences to the site workers are moderate and low for facility and collocated workers. For radioactive materials, consequences are low and negligible for facility and collocated workers. Because of the high risk of nonradioactive materials to facility workers, corrosion-resistant materials are safety significant, and maintenance and inspections of the system are a TSR requirement.

3.2.2.1.3 Confinement ***Entries***—This scenario is from the safety analysis for the OU 7-10 Glovebox Excavator Method Project.[2] Entries into contaminated confinements may be required. A failure of personal protective equipment (PPE) such as respiratory protection or a failure to properly don PPE could result in facility worker exposures to airborne materials. These types of initiators are anticipated. The safety analysis for the OU 7-10 Glovebox Excavator Method Project demonstrates that, for retrieval, facility worker exposures would be moderate for radioactive material hazards and low for nonradioactive materials. This same assessment could be made for treatment options. Collocated workers and off-Site public could not be impacted by this scenario.

3.2.2.1.4 Ventilation System ***Failure***—This scenario is from the safety analysis for the OU 7-10 Glovebox Excavator Method Project.[2] The scenario evaluates risks associated with a failure of the ventilation system when the confinements are in place. The scenario assumes that airflow through the confinements is greatly reduced because of a mechanical failure in a ventilation system component such as a fan. (Loss of ventilation from other initiators are addressed under other scenarios.) Mechanical failures are anticipated. The accident analysis for the OU 7-10 Glovebox Excavator Method Project evaluates the loss of ventilation flow scenario. The accident analysis assumes no confinement and an unlikely source term. The radioactive material exposure consequences to collocated workers and the off-Site public justify radiation-related consequences of low for facility workers and negligible for collocated workers and off-Site public. The concentrations of nonradioactive materials justify nonradioactive material consequences of low for facility workers and negligible for the off-Site public. Assumptions in the accident analysis bound consequences of a loss of functionality for treatment control and safety systems. No safety SSCs or TSRs are identified at this stage of the analysis. A safety requirement is identified to ensure that the system is maintained and inspected and to ensure that the frequency for these types of failures is reduced.

3.2.2.1.5 Direct Radiation — The following of scenarios address the hazards of exposure to high-radiation fields during retrieval of materials from OU 7-10 and the rest of the SDA:

- **High-radiation fields in Operable Unit 7-10.** This scenario is from the safety analysis for the OU 7-10 Glovebox Excavator Method Project.[2] The inventory discussion in Section 3.2.1.3.1 indicates that a high-radiation hazard in OU 7-10 is extremely unlikely. If encountered, consequences are high for the facility worker. Considering the inverse square law, exposures to collocated workers and off-Site public are negligible. Safety SSCs, TSRs, or safety requirements are not required.

- **High-radiation fields at the Subsurface Disposal Area.** The inventory discussion in Section 3.2.1.4 indicates that highly radioactive waste materials are buried at other areas of the SDA. Therefore, an exposure during retrieval or treatment at areas other than OU 7-10 is anticipated, and consequences to facility workers are high. Considering the inverse square law, consequences to collocated workers and off-Site public are negligible. Shielding is identified as a safety-significant SSC, and radiation monitoring is identified as a TSR for protection of facility workers.

3.2.2.1.6 Excavation ***Sloughing***—This scenario is from the safety analysis for the OU 7-10 Glovebox Excavator Method Project.[2] A large sloughing event during excavation could result in large airborne releases of waste-zone material. Without controls, this scenario is anticipated. Assuming no confinement, an unprotected worker near the event could receive doses in the moderate range for radioactive and nonradioactive materials. Results of accident analysis for the OU 7-10 Glovebox

Excavator Method Project indicate that consequences to collocated and off-Site receptors would be negligible. The high risk to the facility worker requires that excavation confinement structure be safety significant. A TSR is not required for this scenario.

3.2.2.1.7 Criticality—Risk bin numbers are not identified for criticality scenarios. If criticality is possible, some engineering and administrative controls are safety significant or TSRs. The following scenarios address the risk of criticality for the retrieval treatment options and for storage:

- **Criticality in incinerator, desorption unit, or melter.** This scenario is from an incinerator scenario in the PSAR for the AMWTP.[3] The postulated scenario assumes that a large mass of fissile material accumulates in a reactive geometry in the incinerator burn chamber or in an ash collection chamber, in materials in a thermal desorption unit, or in a melter slag and that the material becomes moderated by free liquids. The frequency and controls for this scenario are from the PSAR. Potential consequences for a criticality accident in a microencapsulation ash drum are calculated in the PSAR. The results justify consequences of high, moderate, and negligible for facility workers, collocated workers, and the off-Site public, respectively. The engineering control is a criticality alarm system, which is a safety-significant SSC. The TSR administrative controls are assay and characterization before treatment, feed rate controls, free liquid controls, and a criticality control program.

- **Criticality during retrieval.** This scenario is from the OU 7-10 Glovebox Excavator Method Project safety analysis.[2] Postulated scenarios assumed that a large mass of fissile material is retrieved or accumulates and that the material becomes moderated by free liquids. All scenarios are determined by the analysis to be extremely unlikely. Consequences for the retrieval scenario are assumed the same as for the thermal treatment scenario. Controls will likely focus on free liquid control in the pit, carts, and monitor canisters; container loading controls; and a requirement for a criticality alarm system. Engineering controls are safety significant. Administrative controls are addressed by TSRs. Other controls or scenarios may be identified in a criticality safety evaluation when the specific retrieval option is selected and the design nears completion.

- **Criticality during sorting.** This scenario is from the PSAR for the AMWTP.[3] The postulated scenario assumes retrieval or accumulation of a minimum critical mass and a reactive geometry and is moderated by free liquids. The frequency and consequences are from the PSAR. The frequency is determined extremely unlikely. Potential consequences are assumed the same as those for the thermal treatment scenario. Engineering and administrative controls are similar to those for retrieval. One additional control is a TSR for assaying and characterizing material.

- **Criticality in off-gas system.** This scenario is from the PSAR for the AMWTP.[3] The postulated scenario assumes that a large mass of fissile material accumulates in a reactive geometry in a wet scrub system in the off-gas treatment system. Frequency and consequences for this scenario are from the PSAR. The frequency is determined extremely unlikely. Consequences are assumed identical to consequences for the thermal treatment scenario. Engineering and administrative controls are also similar to those for the thermal treatment scenario. One additional control may be a safety-significant process design feature that prevents accumulation of fissile materials in a reactive geometry.

- **Criticality in the compactor.** This scenario is from the PSAR for the AMWTP.[3] The postulated scenario assumes that a large mass of fissile material accumulates in a reactive geometry in the compactor or in a compacted drum of material referred to as a "puck" in the compactor and that the material becomes moderated by free liquids in the puck or by another source. The frequency is determined extremely unlikely. Consequences are assumed the same as for the thermal treatment scenario. Engineering and administrative controls are similar to those for the other criticality scenarios.

- **Criticality in the shredder.** This scenario is from the PSAR for the AMWTP.[3] The postulated scenario assumes that a large mass of fissile material accumulates in a reactive geometry in the shredder and that the material becomes moderated by free liquids. The frequency is determined extremely unlikely. Consequences are assumed the same as those for the thermal treatment scenario. Engineering and administrative controls are identical to those for compaction.

- **Criticality in a feed system.** This scenario is from the PSAR for the AMWTP.[3] The postulated scenario assumes that a large mass of fissile material accumulates in a reactive geometry in an incinerator, shredder, desorption unit, or melter feed device (assumed to be an auger) and that the material becomes moderated by free liquids. The frequency is determined extremely unlikely. Consequences are assumed the same as those for the thermal treatment scenario. Engineering and administrative controls are identical to those for the shredder scenario.

- **Criticality in leaching process.** The postulated scenario assumes that a large mass of fissile material accumulates in leaching process equipment and that the material becomes moderated by free liquids. Without more information on design or evaluation in a criticality safety evaluation, the frequency for this scenario is qualitatively assessed as unlikely because of the nature of this treatment option, which is to leach out and accumulate metals. Consequences are assumed the same as for the thermal treatment scenario. Engineering controls on the system design, such as process tanks less than 6 in. in diameter, may be required to prevent the accumulation of fissile materials in reactive configurations. With the exception of free liquid control, the administrative controls are identical to those for other treatment options.

- **Overloading a container.** The postulated scenario assumes that a container, such as a drum or box, is overloaded (>380 fissile gram equivalent) with fissile material during one of the retrieval or treatment processes and that near-optimum conditions of moderation and geometry exist in the container. In the absence of a criticality safety evaluation, the frequency is assessed as extremely unlikely because of the conditions that must exist. Consequences are assumed the same as for compaction. Engineering and administrative controls are identical to those for compaction.

- **Criticality during storage.** This scenario is from the RWMC SAR.[2] The scenario addresses the risk of a criticality after waste has been retrieved, treated, and packaged and is now in storage. The frequency for this scenario is from the SAR, which demonstrates that conditions for a criticality during storage are beyond extremely unlikely. Consequences are assumed the same as for the thermal treatment scenario.

3.2.2.1.8 Energetic Chemical Reaction — The following scenarios address hazards associated with energetic chemical reactions between incompatible materials:

- **Incompatible waste-zone materials.** This scenario is from the safety analysis for the OU 7-10 Glovebox Excavator Method Project. A chemical compatibility analysis of materials in the OU 7-10 Glovebox Excavator Method Project retrieval area was performed.'' The analysis examined all binary combinations of the chemicals known to be in the area. The result of the examination was that there are no anticipated or postulated reactions that could lead to explosion, rupturing of containers, fire, or uncontrolled release of hazardous materials. The analysis does not rule out the possibility of slow reactions at ambient temperatures or reactions during storage. However, it concludes that during storage, reactions leading to heat buildup and runaway reaction, fire, explosion, or uncontrolled release of gases at a rate sufficient to constitute a danger to human health or the environment would not occur without a strong external heat source. Since waste types in the Stage II retrieval area are typical of RFP waste types buried in other pits and trenches at the SDA, the same assessments can be made for Stage III and other actions on the SDA. Therefore, the probability of having an overpressurization, fire, explosion, or release of large quantities of hazardous gases from the mixing of incompatible waste-zone materials is extremely unlikely. Because there are energetic releases, consequences of this scenario are moderate to the facility workers, low to collocated workers, and negligible to the off-Site public. No safety SSCs, TSRs, or safety requirements are required at this stage of the analysis.

- **Chemical reaction during leaching.** The leaching process involves heating up soil to drive off VOCs and then leaching out metals with nitric acid. During the leaching process, acid could react with calcium carbonate in the soil and foam, produce reaction heat, and pressurize process tanks. The frequency is anticipated because the initiators would likely involve human error or equipment failure in adding the acid or in characterizing the soil before processing. During leaching, radionuclides are in the system; however, the hazard is dominated by exposure to acid. Consequences are assessed as low and moderate for radioactive and nonradioactive materials for the facility workers. Consequences to collocated workers and off-Site public are negligible because the release is limited to the facility. No safety SSCs, TSRs, or safety requirements are identified at this stage of the analysis. A safety requirement is identified for an acid feed control system, which would ensure that the acid is added at a safe rate.

- **Chemical reaction during neutralization.** This scenario is similar to the previous scenario except that it occurs after leaching and involves an energetic reaction when neutralizing the acid with caustic. Therefore, consequences to facility workers are assessed as negligible and moderate for radioactive and nonradioactive materials, and consequences to the off-Site public are negligible. No safety SSCs or TSRs are required at this stage of the analysis. A safety requirement is identified for a caustic feed control system, which would ensure that the caustic is added at a safe rate.

3.2.2.1.9 Fires — The following scenarios address hazards associated with fires during the retrieval, treatment, and storage processes:

- **Fires from repairs.** This scenario is from the safety analysis for the OU 7-10 Glovebox Excavator Method Project.[2] It is expected that repair activities will be required at the retrieval, treatment, and storage facilities. Repair activities involving cutting, grinding, or welding have a high probability of causing a fire if combustible materials in the area are not controlled. Therefore, the initiator for this scenario is anticipated. Facility worker consequences are low and negligible for radioactive and nonradioactive materials. The fire could occur in areas, such as a hopper or feed system, that would contain combustible waste-zone materials that present a negligible nonradioactive material hazard. Consequences to other receptors are negligible because of dispersion over the distance from the release. Safety SSCs and TSRs are not required for this scenario. A safety requirement is identified for combustible material control.

- **Fires from electrical components.** This scenario is from the safety analysis for the OU 7-10 Glovebox Excavator Method Project.[2] This scenario is identical to the repair scenario except that the initiator is a failure in a component of the electrical or heating system. No safety SSCs or TSRs are identified at this stage of the analysis. A safety requirement is identified for ensuring that the design and installation of electrical systems meet the applicable codes.

- **Fires from diesel-powered equipment.** This scenario is from the RWMC SAR.[2] The retrieval options involve a commercially available diesel-powered excavator. Diesel powered forklifts or trucks also could be used to transport containers from the treatment area to storage or from storage to a TRUPAC II loading facility. A fuel spill to the engine compartment during refueling because of a fuel system failure could ignite resulting in a large energetic fire. The hazard and accident analyses in the RWMC SAR evaluate this scenario as a bounding condition. The analyses demonstrate that the frequency is unlikely, that the radioactive material exposure consequences are moderate and low for the facility and collocated workers, and that the nonradioactive consequences are low and negligible for the facility and collocated workers. Consequences to the off-Site public are negligible. The safety analysis identifies TSR administrative controls for the fire protection program, waste handling procedures, operator training, and an emergency preparedness program. No safety SSCs are identified at this stage of the analysis.

- **Fire in the retrieval area.** The accident analysis for the OU 7-10 Glovebox Excavator Method Project[2] evaluates a fire involving 20 drum-equivalent volumes of waste-zone materials in the retrieval pit. For the average radioactive and nonradioactive material concentrations, this scenario is unlikely. For unlikely concentrations, the scenario is extremely unlikely. For the extremely unlikely scenario, the radioactive material consequences at the collocated worker location are moderate, low, and negligible for the facility worker, collocated worker, and off-Site public. For a large fire involving chlorinated hydrocarbons, the nonradioactive material hazard is primarily from the potential products of combustion such as phosgene. For the extremely unlikely scenario, the phosgene concentrations at the collocated worker location could exceed the Emergency Response Planning Guideline-3 concentration. Therefore, the nonradioactive material consequences are high for the on-Site workers and low for the off-Site public. The safety analysis identifies the confinement structure as safety-significant SSCs and TSRs for the fire protection and emergency preparedness programs.

- **Fire in a thermal treatment feed system.** This scenario is from an incinerator scenario in the AMWTP PSAR.[3] Combustible waste materials in a feed hopper are ignited because of heat or embers from the incinerator, thermal desorption unit, or melter. The hazard analysis in the PSAR determined that this scenario is anticipated and that the radioactive consequences to the facility worker are low. For this fire scenario, consequences of nonradioactive material are considered negligible because the fire involves combustible waste-zone materials, which do not pose a nonradioactive material hazard. Consequences to all other receptors are negligible because of dispersion over the distance from the source. No safety SSCs or TSRs are identified at this stage of the analysis. A safety requirement is identified to ensure that the feed system is designed to prevent fires in the hopper caused by radiant heat or embers.

- **Fire in the shredder.** This scenario is from the AMWTP PSAR.[3] The initiators for this fire scenario are the heat from excess friction if the shredder components are not properly adjusted or maintained, a spark from metallic waste materials that ignites combustible waste, or shredding prohibited items such as a pressurized aerosol can. The frequency and consequences for this scenario are the same as those for the feed system scenario discussed above. A safety requirement is identified for inerting the shredder to prevent fires. No safety SSCs or TSRs are identified at this stage of the analysis.

- **Fire in the compactor.** This scenario is from the AMWTP PSAR.[3] The initiators for this scenario are sparks that ignite combustible waste or compacting prohibited items such as a pressurized aerosol can. The frequency and consequences for this scenario are the same as those for the feed system scenario discussed above. A safety requirement is identified for inerting the compactor to prevent fires. No safety SSCs or TSRs are identified at this stage of the analysis.

- **Fire during storage.** This scenario is from the RWMC SAR.[4] The scenario involves spontaneous ignition of waste materials in a drum. Analyses in the SAR demonstrate that the initiating event is anticipated. The consequence assessments are based on accident analysis results in the SAR. The accident analysis assumes a single drum fire with an unlikely source term. The results are that none of the radioactive material evaluation guidelines are challenged. The evaluation guidelines (Emergency Response Planning Guideline-2) for lithium chromate and mercury are exceeded for the collocated worker but are not challenged for the off-Site public. Results of the RWMC safety analysis indicate that nonradioactive material consequences are high for the facility worker, low for the collocated worker, and negligible for the off-Site public. No safety SSCs are identified at this stage of design. The TSRs are required for fire protection, waste-handling procedures, operator training, and the emergency preparedness program.

3.2.2.1.10 Explosions — For explosion scenarios, it is assumed that consequences from radioactive and nonradioactive materials are about the same. The following scenarios address the hazards associated with explosions during the retrieval, treatment, and storage processes.

- **Explosive mixtures of volatile organic compounds in waste-zone materials.** This scenario is from the safety analysis for the OU 7-10 Glovebox Excavator Method Project.[2] This scenario involves a buildup of gases in a glovebox or other confinement. The safety analysis concluded that, based on the inventory in the retrieval, the scenario is beyond extremely unlikely. This frequency is not expected to change for other retrieval areas at the SDA. No safety SSCs, TSRs, or safety requirements are identified at this stage of design.

- **Drum explosion during retrieval.** This scenario is from the safety analysis for the OU 7-10 Glovebox Excavator Method Project and other portions of the RWMC SAR.[2] The scenario involves retrieving an intact drum pressurized with a flammable mixture of hydrogen and air in the drum headspace. The OU 7-10 Glovebox Excavator Method Project safety analysis (Addendum J to RWMC SAR) determined that frequency for retrieving an intact drum from the SDA is extremely unlikely. There is no reason to hypothesize that the frequency would change for other retrievals at the SDA. The accident analysis in the main body of the RWMC SAR evaluates consequences of a drum explosion. Results of the consequence analysis justify consequences of medium, low, and negligible for the facility workers, collocated workers, and off-Site public, respectively, for the unlikely scenario. No safety SSCs, TSRs, or safety requirements are identified at this stage of design.

- **Flammable microbial gases.** This scenario is from the safety analysis for the OU 7-10 Glovebox Excavator Method Project.[2] It involves the generation of methane and hydrogen gas from microbial action on organic materials in the SDA. There is no reason to hypothesize that the frequency or consequences would change for other retrievals at the SDA. No safety SSCs, TSRs, or safety requirements are identified at this stage of design.

- **Pressurized container in a thermal treatment system.** This scenario is from an incinerator scenario in the PSAR for the AMWTP.[3] It assumes that a pressurized container such as a gas cylinder is not identified and sorted during segregation and is placed in the incinerator, desorption unit, or melter. During thermal treatment, the container ruptures, and the treatment system is damaged by missiles from the container and overpressurization. The PSAR assesses the frequency as unlikely and the consequence as low for the facility worker. Consequences to the collocated worker and off-Site public are negligible. These frequency and consequence assessments are reasonable because pressurized gas cylinders are not expected, and this type of damage will result in localized consequences. No safety SSCs, TSRs, or safety requirements are identified at this stage of design.

- **Thermal treatment of organics and nitrates.** This scenario involves an energetic reaction in waste-zone materials undergoing thermal treatment. The chemical compatibility analysis[14] for the OU 7-10 Glovebox Excavator Method Project safety analysis did not rule out reactions during fire events. Combinations of nitrates with carbonaceous materials such as charcoal, graphite, and cellulose could react vigorously in temperatures in excess of 392°F. These types of materials are in the waste inventory and could be combined during retrieval. The reaction would likely overpressurize and damage the thermal treatment system and result in a release. The initiators for this scenario are a failure to segregate organics and nitrates before treatment or a failure to control the treatment system feed rate. Two independent actions allow for a frequency designation of unlikely. For this scenario, facility workers and collocated workers would be severely injured if not killed by heat and debris from the incident. Therefore, consequences to on-Site workers are assumed high and moderate for these reasons alone. Consequences to the off-Site public are assumed low because of the potential energy of the release. No safety SSCs are identified at this stage of the analysis. A TSR is identified for sorting materials before treatment or for establishing a feed rate to ensure that the hazard of thermally treating organic and nitrate mixtures is reduced.

- **Excessive incinerator fuel flow.** This scenario is from the PSAR for the AMWTP.[3] The PSAR assumes a frequency of unlikely for the scenario. This frequency can be assumed for Stage III if the incinerator design demonstrates that at least two independent failures or conditions must occur. The consequence designations are based on results of accident analysis in the PSAR. The analysis assumes maximum inventories, which lowers the scenario frequency to extremely unlikely. The results of the analysis indicate that the radioactive consequences are high, moderate, and low for the facility worker, collocated worker, and off-Site public, respectively, and that the nonradioactive material consequences are low for facility workers and negligible for collocated workers and the off-Site public. For this scenario, facility workers and collocated workers would be severely injured if not killed by heat and debris from the incident. Consequences to on-Site workers are assumed high and moderate for these reasons alone. The incinerator fuel control system and incinerator confinement are designated safety significant. A TSR administrative control is identified for an emergency protection program.

- **Incinerator flameout.** This scenario is from the PSAR for the AMWTP.[3] The scenario involves an incinerator flameout, uninterrupted fuel flow to the burner, and attempts to reignite the flame. The frequency and consequences are identical to those discussed for the fuel supply fault scenario. For the flameout scenario, the incinerator fuel control system and confinement are designated safety significant, and TSR administrative controls are identified for restart procedures after a flameout and the emergency preparedness program.

- **Propane tank boiling liquid-expanding vapor explosions.** This scenario is from the RWMC SAR.[2] Propane tanks could be located near the facilities to support treatment options such as incineration. Most boiling liquid-expanding vapor explosions (BLEVEs) of stationary tanks occur because of errors or failures during tank-filling operations that result in an impinging fire. The fire eventually causes a BLEVE of the tank. Assuming no safety features or controls are in place, the RWMC SAR reports the frequency for a BLEVE as unlikely. The BLEVEs are high-energy events and have the potential for severe damage, fatalities, and large releases. Therefore, consequences are high for on-Site workers and low for the off-Site public. The time between the initiating event and the BLEVE event is normally long enough to allow worker evacuations and public notifications directed under the emergency preparedness program. For this scenario, safety features on a tank designed to prevent a BLEVE are safety significant, and a TSR is required for an emergency preparedness program. The BLEVEs from external events are bounded by this scenario.

- **Buildup and ignition of flammable gases.** This scenario is from two occurrence reports: SR-WSRC—WIT—197—0020 and ORO-BNI-FUSRAPCISS-1996-0001 (see Table 3-3). The Savanna Ever report discusses the safety systems required for a melter to prevent an explosion. Apparently, the safety analysis for the melter postulates that an explosive atmosphere can be created in the melter or in the off-gas system if specific melter safety systems fail. The Oak Edge (ORO) report discusses the occurrences of flashes during a thermal desorption process. Similar scenarios can be postulated for all three thermal treatments being considered for Stage III. The frequency for the scenarios in any one of the systems is considered unlikely. Potential consequences of the events are the same as for other explosion scenarios. Thermal treatment systems that monitor, heat, or combust the off-gases in the treatment unit during operations or that limit the feed rate of waste materials would be designated safety significant. A TSR control may be required to ensure that the operating procedures identify the appropriate actions if explosive conditions were to occur.

- **Dust cloud explosion during shredding.** This scenario is from the PSAR for the AMWTP.[3] The PSAR hazard analysis assumes an unlikely frequency and low consequences to the facility workers. These assessments appear to be reasonable given that the waste-zone materials are of a type that typically would not result in explosive dust clouds, and the facility worker exposures would be expected to be no worse than the lower consequence incinerator overpressurization scenarios. The inerting system is identified as a safety-significant component of the shredder. No TSRs or safety requirements are identified at this stage of the analysis.

- **Drum explosion during storage.** This scenario is from the RWMC SAR.[2] A drum explosion during storage with the average source term is determined by the SAR to be unlikely. Consequences for this scenario are identical to the scenario for a drum explosion during retrieval. There are no safety SSCs. A TSR control may be required for ensuring drums are vented to meet the storage waste acceptance criteria.

3.2.2.1.11 Drops — Drum drops are addressed under the breach of a storage container scenario in Section 3.2.2.1.1. The following scenarios address accidents that occur when transporting containers:

- **Compactor puck drop.** This scenario is from the PSAR for the AMWTP.[3] The scenario involves a drop of a compacted drum (or puck) during movement. This scenario is anticipated based on past material-handling accidents at the RWMC. Consequences would be limited to a small, localized release of radioactive material. Therefore, consequences are low to the facility worker and negligible for all other receptors and nonradioactive materials. No safety SSCs or TSRs are identified at this stage of the analysis. A safety requirement for equipment operator training is identified.

- **Tote-bin drop.** Tote bins are 4 x 4 x 6-ft metal bins that may be used to transport contaminated materials to the melter, incinerator, or thermal desorption units. The bins also are used as the feed bins for the units. A drop of these bins during transport is anticipated based on past material-handling accidents at the RWMC. Because of the large volume of the bins, consequences of a drop could be more severe than other drop scenarios addressed under this hazard group. Therefore, radioactive material exposure consequences to the facility worker and collocated worker are assumed moderate and low, respectively. The nonradioactive material exposure consequences are assumed low for the facility worker and negligible for collocated workers. Consequences to the off-Site public are negligible for both material types because of dispersion between the release and the nearest off-Site boundary. No safety SSCs are identified at this stage of design. Operator training is identified as a TSR.

3.2.2.7.72 ***Material*** Spills — The following scenarios address accidents that occur when filling waste containers or chemical batch containers during the retrieval and treatment processes:

- **Spill during drum loading.** This scenario is from the safety analysis for the OU 7-10 Glovebox Excavator Method Project.[2] It assumes an error in connecting a drum to a drum loadout port on a glovebox, and waste-zone materials are spilled to the work environment during drum loading. Human errors are generally anticipated initiators. The hazard is a localized, nonenergetic release of primarily radioactive materials. Therefore, the radioactive material consequences are low to the facility worker and are negligible for all other receptors and for nonradioactive materials. No safety SSCs or TSRs are identified at this stage of design. A safety requirement is identified for training to ensure that operators correctly package the materials.

- **Spill or leak from acid or caustic batch tanks.** This scenario assumes human error or a failure in equipment during acid or caustic batch tank filling. The error or failure results in a large pressurized release. The frequency of the accident is assumed anticipated because of the initiators. The scenario also assumes that a worker nearby is sprayed by the release and that the release continues unchecked resulting in a large pool of spilled material. The acid or caustic vapors are transported downwind to collocated workers. Consequences are assumed high for the facility worker and moderate for collocated workers. There would be no releases of radioactive materials. Safety SSCs may include safety-significant components of the batch tanks or fill pumps, which would prevent a large spill. The TSRs for worker training, PPE, and possibly for remote filling operations may be required.

- **Spill or leak from anhydrous ammonia batch tank.** The initiators, consequences, and controls for this scenario are the same as those for the acid and caustic batch tank release scenario.

3.2.2.1.13 ***Internal Flooding***—The following scenarios look at the possible effects of flooding from other-than-natural events on the retrieval and treatment processes:

- **Contaminated area flooding.** This scenario is from the safety analysis for the OU 7-10 Glovebox Excavator Method Project.[2] The scenario assumes a break in a water line or fire protection system line and facility flooding. The break could be caused by human error during maintenance, repair, or other operations. Therefore, the scenario is assumed anticipated. Consequences would be limited to the spread of unconfined waste-zone materials rather than worker exposures. Therefore, consequences at all receptor locations are negligible for radioactive and nonradioactive materials. The environmental impact is low because of the possible spread of contamination outside the facility. No safety SSCs, TSRs, or safety requirements are identified at this stage of design.

- **Thermal treatment area flooding.** This scenario is from an incinerator scenario in the PSAR for the AMWTP.[3] The initiators for this scenario are identical to those for the previous internal flooding scenario; however, for thermal treatment, consequences could be more severe. Flooding of the treatment system confinement could result in severe thermal shock to system metals and a release of materials. Consequences should be identical to consequences for the thermal cycling scenario discussed under a breach of confinement. No safety SSCs or TSRs are identified at this stage of design. A safety requirement is identified for flood control in the facility to ensure that the thermal treatment units are not impacted.

3.2.2.2 ***External Scenarios.*** This group represents the hazards and scenarios external to the operations of the Stage III facility but which could affect operations if the scenarios occur.

3.2.2.2.1 External ***Flooding—***This scenario involves flooding from a collocated facility that floods a retrieval, treatment, or storage facility. The frequency, consequences, and controls are identical to those identified for the internal flooding scenario under operational events.

3.2.2.2.2 Transportation ***Accidents—***Consequences from radioactive and nonradioactive materials are assumed the same for this group of scenarios. The following scenarios evaluate the hazards from vehicles and aircraft:

- **Vehicle impact with a facility.** For this scenario, it is assumed that a vehicle impacts a retrieval, treatment, or storage facility. Initiators for this scenario are operator error or equipment malhnction. These types of initiators are normally considered anticipated; however, the frequency for the scenario is considered unlikely because of relatively light traffic at the RWMC and vehicle speeds. The worst-case consequences are low for the facility worker and negligible for all other receptors. No safety SSCs, TSRs, or safety requirements are required at this stage of design.

- **Vehicle impact with chemical batch tanks.** This scenario involves a vehicle impact with a batch acid or caustic tank and a large spill. The frequency for this scenario is the same as for the facility impact scenario. Consequences are the same as for the scenario for a spill from a batch tank. The facility layout should consider placing tanks in low-traffic areas of the RWMC. Barriers that prevent impacts with the tanks could be safety-significant SSCs, and a TSR for an emergency protection program may be required.

- **Vehicle impact with a propane tank.** This scenario involves a vehicle impact with a propane tank. The accident results in an impinging fire on the tank that eventually causes a BLEVE. The frequency of extremely unlikely is the product of two unlikely scenarios: a vehicle accident and an impinging fire. Consequences are the same as for the BLEVE discussed under operational scenarios. No safety SSCs or TSRs are identified at this stage of design. A safety requirement is identified for vehicle impact barriers around the tank that would prevent the impact.

- **Aircraft impact.** This scenario is from the RWMC SAR.[2] The scenario assumes that an aircraft fails in some way and impacts the RWMC. Aircraft impacts caused by terrorist activities are not considered in safety analyses. Facility-specific aircraft impact frequencies are calculated using the methodology recommended in DOE-STD-3014-96, "Accident Analysis for Aircraft Crash into Hazardous Facilities."[19] Using this methodology for the INEEL generally results in impact frequencies in the 10^{-7}/year range.[2] Consequences of an aircraft impact at the RWMC could involve multiple storage and processing facilities. Therefore, consequences are assumed high for all on-Site workers and moderate for the off-Site public. No safety SSCs or TSRs are required at this stage of the analysis.

3.2.2.2.3 Fires — The following scenarios involve fires that start in other areas of the RWMC and brush fires outside the RWMC and their potential impacts on operations:

- **Radioactive Waste Management Complex fire.** This scenario is from the RWMC SAR.[2] The frequency for this type of scenario is considered anticipated because of the large number of range fires that have occurred and the nature of possible initiators. Assuming no confinement features or mitigation, consequences reported in the SAR are moderate and low for facility and collocated workers and negligible to the off-Site public. The TSRs are required for combustible material control within the RWMC and an emergency protection program that ensures worker safety by evacuation. No safety SSCs are identified at this stage of design.

- **Desert fire.** This scenario is identical to the RWMC fire except for the origin.

3.2.2.2.4 Loss *of* Electrical Power — This scenario assumes that electrical power is lost because of a failure in the INEEL or off-Site power grid. Operational history at the INEEL indicates that this scenario is anticipated. In the absence of backup power supplies, there could be a loss of ventilation flow and treatment and safety system functions. Consequences for this external scenario are the same as those for the operational loss of ventilation scenario. No safety SSCs or TSRs are identified at this stage of design. A safety requirement is identified for a standby generator.

3.2.2.2.5 Pit Subsidence External to Retrieval Facility — This scenario is from the OU 7-10 Glovebox Excavator Method Project safety analysis.[2] Based on operational history at the SDA, a pit subsidence is anticipated, and consequences are limited to possible contamination near the event. There could be no consequences to any of the potential receptors. No safety SSCs, TSRs, or safety requirements are identified at this stage of design.

3.2.2.3 Natural Events. The following sections discuss the potential for releases caused by natural events such as wind and earthquakes on the operational facilities.

3.2.2.3.1 Lightning — This scenario is from the OU 7-10 Glovebox Excavator Method Project safety analysis.[2] The frequency is based on strike data at the INEEL and the dimensions of the facilities. Assuming no lightning protection, a fire could occur in combustible materials and result in a small release. Consequences are low for the facility worker and negligible for all other receptors. Lightning protection for facilities is addressed in the U.S. Department of Energy Idaho Operations Office (DOE-ID) *Architectural Engineering Standards*.[20]

3.2.2.3.2 Volcanic Activity — This scenario is from the RWMC SAR.[2] A volcanic event at the INEEL is extremely unlikely. Consequences are moderate for on-Site workers and negligible to the off-Site public. Indicators of impending volcanic activity are monitored and provide sufficient time for action to protect facilities and the receptors or to relocate packaged waste materials.

3.2.2.3.3 ***Earthquake***—The DOE O 420.1A, "Facility Safety,"[21] and the DOE-ID *Architectural Engineering Standards*[20] identify the requirements for protection of INEEL facilities and safety SSCs from earthquakes. Safety-significant SSCs must be designed to at least Performance Criteria (PC)-2 requirements for earthquakes. For PC-2, SSCs must be capable of performing their safety functions during and after ground accelerations from earthquakes corresponding to a return frequency of 1E-03/year. For the retrieval, treatment, and storage options, earthquakes have the potential of combining many scenarios in one large release event. There is a potential for loss of ventilation, fires in combustible waste materials, breaches of confinements, and breaches in waste storage containers. For the leaching option, there could also be breaches in process chemical batch tanks and lines. For the incinerator option, there could be an incinerator explosion. Therefore, consequences to on-Site workers are assumed to be high, and consequences to the off-Site public are low. The confinements, incinerator components that prevent an explosion; batch tanks; and process lines should be designed to at least PC-2 earthquake criteria.

3.2.2.3.4 High Wind—The DOE O 420.1A[21] and the DOE-ID *Architectural Engineering Standards* identify the requirements for protection of INEEL facilities and safety SSCs from high winds. Safety-significant SSCs must be designed to at least PC-2 requirements for wind protection. For PC-2, SSCs must be capable of performing their safety functions during and after wind speeds corresponding to a return frequency of 1E-02/year. Possible consequences of the scenario are loss of electrical power, confinement pressurization, damage to confinements, or damage to chemical batch tanks. Facilities are not required to protect from wind-borne missiles for PC-2 design. Consequences are low for the facility worker and negligible for all other receptors.

3.2.2.3.5 Snow Loads — The design basis snow load for INEEL facilities is found in the DOE-ID *Architectural Engineering Standards*. The assumed frequency for the snow load is anticipated.

Consequences would be structural failures and confinement breach. Consequences are low for the facility worker and negligible for all other receptors.

3.2.2.3.6 ***Flooding—***The DOE O 420.1A[21] and the DOE-ID *Architectural Engineering Standards* identify the requirements for protection of INEEL facilities and safety SSCs from flooding. Safety-significant SSCs must be designed to at least PC-2 requirements for flood protection. For PC-2, safety-significant SSCs must be capable of performing their safety hnctions during and after floods corresponding to a frequency of 5E-04/year. Possible consequences of the scenario are loss of electrical power and confinement breaches. Consequences are limited to environmental damage because of contamination spread by the floodwaters. Consequences are negligible for all receptors.

3.3 Summary

Potential hazards and operational, external, and natural events associated with retrieval and treatment options are identified and discussed. Included is a discussion of the radioactive and nonradioactive hazardous material inventories that could be encountered in OU 7-10 and in other areas of the SDA. Release and exposure events are postulated with consideration for each of the retrieval and treatment options identified at preconception design. Risks for each scenario are developed, and preliminary safety SSCs (i.e., safety significant or safety class) and technical safety requirement controls that may be needed are identified. Safety-significant SSCs have been identified for several scenarios; however, at this stage of the analysis and design, there are no safety-class SSCs. Table 3-13, Table 3-14, and Table 3-15 list the safety-significant SSCs, TSRs, and safety requirements, indicated by shading, for retrieval, each of the treatment options, and storage. Hazards to the environment also are mitigated or prevented by application of safety SSCs and TSRs.

Table 3-13. Safetv-significant svstems. structures. and components.

Safety-Significant Systems, Structures, and Components by Hazard Group	Retrieval	Compacter	Shredder	Incinerator	Desorption	Melter	Leaching	Storage
Breached confinement								
Ventilation system	■	■	■	■	■	■	■	
Confinement pressure relief system	■	■	■	■	■	■	■	
Primary confinements	■	■	■	■	■	■	■	
Confinement design for pit subsidence	■							
Acid and caustic resistant process materials							■	
Direct radation								
Shielding	■							
Excavation sloughing								
Primary confinements	■							
Criticality								
Criticality alarm system	■	■	■	■	■	■	■	
Container dimensions or volumes	■	■	■	■	■	■	■	
Process design features				■	■	■	■	
Fire								
Primary confinements				■				
Explosion								
Incinerator fuel control system				■				
Propane storage system design				■				
Inert atmosphere for prevention of dust explosions			■					
Vehicle impact barriers around propane tanks							■	
Off-gas safety systems for thermal treatment units				■	■	■		
Spill								
Batch chemical tank or pump design to prevent spills							■	
Vehicle impact barriers around batch chemical tanks							■	

Table 3-14. Technical safety requirements.

Technical Safety Requirements by Hazard Group	Retrieval	Compacter	Shredder	Incinerator	Thermal Desorption	Melter	Leaching	Storage
Breached confinement								
Equipment ıp rato g to d the frequency of breach of confinement accidents								
Hoisti and rigging program to reduce tl frequency of material-handling :ci t								
Emergency preparedness program to ensure worker notification l evacuation								
Waste segregation before treatment and t t identify pressurized gas cylinders								
Stroke speed control to prevent compactor overpressurization								
Maintenance and inspection of process lines to prevent chemical leaks								
t ent								
Radiation control and industrial hygiene programs for selection and use of personal protective equipment								
Direct radiation								
Monitoring for direct radiation								
Criticality								
Assay and characterize waste before treatment to d fissile material loading								
Feed rate controls to d fissile material loading								
Free liquid controls to reduce moderation								
Criticality c p								
Container-loading controls for fissile materials								

Table 3-14. (continued)

Technical Safety Requirements by Hazard Group	Retrieval	Compacter	Shredder	Incinerator	Thermal Desorption	Melter	Leaching	Storage
Fire								
Fire protection program	■							■
Waste-handling procedures								■
Emergency preparedness program to ensure worker notification and evacuation	■	■	■	■	■	■	■	■
Equipment operator training for response to fuel spills and fires	■	■	■	■	■	■	■	■
Combustible material control at the Radioactive Waste Management Complex	■	■	■	■	■	■	■	■
Explosion								
Sorting to identify mixtures of organics and nitrates before thermal treatment				■	■	■		
Emergency preparedness for worker notification and evacuation before a boiling liquid-expanding vapor explosion				■				
Incinerator restart procedures after flameout				■				
Container venting before storage								■
Procedures for operation of thermal treatment units				■	■	■		
Drop								
Equipment operator training to reduce frequency for drop of tote bins				■	■	■		
Chemical batch tank filling operator training							■	
Spills								
Remote filling of chemical batch tanks							■	
Personal protective equipment during chemical batch tank filling							■	
Emergency preparedness for worker notification and evacuation							■	

Table 3-15. Safety requirements.

Safety Requirements by Hazard Group	Retrieval	Compacter	Shredder	Incinerator	Thermal Desorption	Melter	Leaching	Storage
Breached container								
Equipment operator training to reduce frequency of breach-of-confinement accidents	■	■	■	■	■	■	■	■
Breach of confinement								
Protection of glovebox gloves from punctures	■	■	■	■	■	■	■	
Dust suppression	■							
Thermal process operator training to reduce thermal cycling				■	■	■		
Off-gas control system				■	■	■		
Treatment feed rate controls to reduce materials in off-gases				■	■	■		
Ventilation system failure								
Maintenance and inspection of ventilation system components	■	■	■	■	■	■	■	
Standby generator for loss of electrical power	■	■	■	■	■	■	■	
Energetic reactions								
Acid feed control system to control leaching reactions							■	
Caustic feed control system to control neutralization reactions							■	
Fires								
Combustible material control in operator areas	■	■	■	■	■	■	■	■
Electrical system design and installation	■	■	■	■	■	■	■	■
Thermal feed system design to prevent fires				■	■	■		
Inerting shredder compartment for prevention of fires			■					
Inerting compactor compartment for prevention of fires		■						

Table 3-15. (continued).

Safety Requirements by Hazard Group	Retrieval	Compacter	Shredder	Incinerator	Thermal Desorption	Melter	Leaching	Storage
Explosions								
Vehicle impact barriers around propane tanks								
Drops								
Equipment operator training to reduce frequency for drop of compactor pucks								
Spills								
)perator training to reduce frequency for spills ing container loading								
Flooding								
Flood control for thermal treatment options								

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